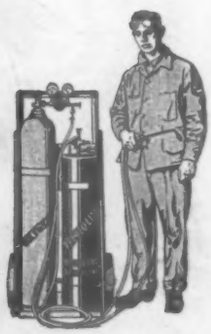
# The Welding Engineer

Vol. II. Chicago 608 S. Dearborn St. OCTOBER, 1917 $2.00 per year in U. S. $2.50 per year abroad No. 10

Prest-O-Lite

Acetylene Service

BACKED by the world's largest acetylene producing and distributing organization —a country-wide system of factory branches, charging plants and exchange stations, insuring prompt, permanent, universal service.



Prest-O-Lite Acetylene Service furnishes the highest grade of dissolved acetylene, ready to use, in portable cylinders of convenient size, for welding and cutting.

It insures maximum efficiency, economy and satisfaction, because Prest-O-Lite is perfectly dried, cleaned and purified. It increases the efficiency of any good welding or cutting apparatus — makes possible better, quicker work, at lower cost.

The Prest-O-Lite Engineering Department is always ready to assist in solving the problems of Prest-O-Lite users. And a staff of skilled welding men, stationed at various centers, is ready at all times to give practical help to our patrons.

*Whatever your welding and cutting problems may be, we will gladly assist in finding the solution. You will receive prompt, expert attention.*

The Prest-O-Lite Co., Inc.

U. S. Main Office and Factory, 851 Speedway, Indianapolis, Ind.
Canadian General Office and Factory, Dept. B. 1, Toronto, Ontario

59 Branches and Charging Plants, in Principle Industrial Centers

World's Largest Makers of Dissolved Acetylene

# Oxweld Service

## Standardize on Oxweld Equipment

### Oxweld Injector Type Blowpipes

Which operate efficiently on the gases other types waste.

### Oxweld Low Pressure and Portable Pressure Acetylene Generators

Produce acetylene at lowest cost. When used with Oxweld Blowpipes it makes the Ideal Combination for job welder or manufacturer.

### Oxweld Tested Welding Supplies

The result of years of experimental work, and kept right by rigid analysis.

## Secure the Best Results at Lowest Cost

*Send for the Oxweld Catalog Sections and Oxweld Supply Catalog No. 3*

## Oxweld Acetylene Company

Newark, N. J. Chicago Los Angeles

World's Largest Manufacturers of Oxy-Acetylene Apparatus

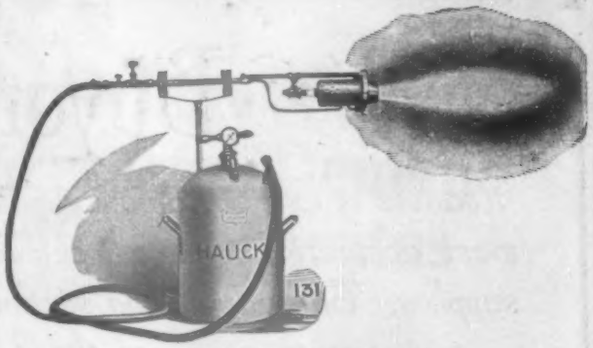
## MILBURN APPARATUS

Milburn mixing principle produces best work with minimum gas, and no flash backs, burnt tips, or other annoyances.

Exceptionally durable construction of torches insures long, satisfactory service. Regulators dependable and free from valve, diaphragm and gauge troubles.

Ask for Catalogue No. 35.

**The Alexander Milburn Company**
Baltimore, Maryland




## HAUCK
## Kerosene Preheater

in connection with your Welding Torch. Reduce the welding time and cut the oxygen and acetylene bills more than half and turn out better work.

## HAUCK MFG. CO.
BROOKLYN, N. Y.

**EFFICIENCY** of a weld not only depends on the manner in which it is executed, but also on the grade and amount of material used.

In view of this, our engineers have developed the highest grade of various welding materials known to the art.

**OXWELD RODS** are furnished in convenient packages and are made for every class of material that can be welded, whether it be copper, brass, aluminum, steel, low or high carbon, chrome vanadium or ordinary steel castings.

We maintain a complete staff of experts qualified to handle and supervise all lines of work.

## Oxweld Railroad Service Company
CHICAGO NEW YORK

## THE K G TORCH

It is a well established fact that the **"torch"** is the most important unit of an oxy-acetylene welding and cutting equipment.

The K-G Torch has a reputation in the trade which speaks for itself. We will gladly demonstrate the torch at any time and we guarantee it to be equal to any and better than most on the market today. Finally, the price will leave no argument open.

The Complete K-G Welding and Cutting Equipment is in every detail as reliable and efficient as the K-G Torch. All K-G supplies are guaranteed to be the highest quality goods.

**Torches, Regulators, Hose, Gloves, Gauges, Goggles, Welding Rods, Wire and Flux, Oxygen, Acetylene and Blau Gas.**

## K-G Welding & Cutting Co.
(INCORPORATED)
556 West 34th St., NEW YORK CITY

# Buyers' Index

*Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.*

**ACETYLENE (Compressed in Cylinders)**
Commercial Acetylene Welding Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

**ACETYLENE CYLINDERS**

**ACETYLENE GENERATORS**
Bermo Supply Co.
Davis-Bournonville Co.
The Harris Calorific Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

**ALUMINUM FILLER RODS**
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Mach. Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**ALUMINUM FLUX**
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**ALUMINUM SOLDER**
Vulcan Process Co.

**ANNEALING FURNACES**
Buffalo Dental Mfg. Co.
Universal Oxygen Co.

**APRONS (Asbestos)**

**ASBESTOS GLOVES**
Vulcan Process Co.

**ASBESTOS SHEET PAPER**
Davis-Bournonville Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**BLOW TORCHES (Acetylene)**
American Welding Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
The Alexander Milburn Co.
The Prest-O-Lite Co.
Vulcan Process Co.

**BOOKS (Relating to Welding)**
The Welding Engineer
P. F. Willis.

**BRASS AND BRONZE FLUX**
American Welding Co.
Ampco Rolling Mills Corp.
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
United States Welding Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.

**BRASS SPELTER WIRE**
Universal Oxygen Co.
Vulcan Process Co.

**BRAZING OUTFITS**
Alger Supply Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.

**BRONZE FILLER RODS**
Ampco Rolling Mills Corp.
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**BUTT WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**CARBIDE (Calcium)**
Canada Carbide Sales Co.
Union Carbide Sales Co.

**CARBO CUTTING AND WELDING APPARATUS**
Carbo-Hydrogen Co. of America

**CARBO-HYDROGEN**
Carbo-Hydrogen Co. of America

**CARBON (Blocks, Paste, Etc.)**
National Carbon Co.

**CARBON REMOVING TORCHES**
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Equipment Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer Mfg. Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Mach. Co.
Universal Oxygen Co.
Vulcan Process Co.

**CAST IRON FILLER RODS AND FLUX**
American Welding Co.
Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**CRANES (Portable)**
H. G. Doran.

**ELECTRIC ARC WELDING OUTFITS**
The Lincoln Electric Co.
Westinghouse Electric & Mfg. Co.
General Electric Co.

**ELECTROLYTIC OXYGEN PLANTS**
International Oxygen Co.
Universal Oxygen Co.
Vulcan Process Co.

**FILLER RODS (Aluminum)**
American Welding Co.
Bierman-Everett Fdy. Co.
Hauck Mfg. Co.
United States Welding Co.
The Prest-O-Lite Co.
Vulcan Process Co.

**FILLER RODS (Swedish Iron)**
American Welding Co.
Bierman-Everett Fdy. Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Steel Sales Corp.
Universal Oxygen Co.
Vulcan Process Co.

**FILLER RODS (Tobin Bronze)**
American Welding Co.
Bermo Supply Co
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Steel Sales Corp.
Vulcan Process Co.
United States Welding Co.
Universal Oxygen Co.

**FILLER RODS (Vanadium Steel)**
American Welding Co.
Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Steel Sales Corp.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**FIREPROOF PLASTIC**
Bermo Supply Co.

**FLUX WELDERS (Electric)**
Westinghouse Electric & Mfg. Co.

**FURNACES (Annealing)**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Universal Oxygen Co.

**GASOLINE PREHEATING FURNACES**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.

**GAS BURNERS (Preheating)**
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.
Vulcan Process Co.

**GLOVES (Welders Asbestos)**
Davis-Bournonville Co.
Vulcan Process Co.

**GOGGLES**
Chicago Eye Shield Co.
F. A. Hardy & Co.
Vulcan Process Co.

**GRINDING MACHINES**

**HARDENING FURNACES**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.

**HOSE (Carbo-Hydrogen)**
Carbo-Hydrogen Co. of America

**HOSE (Oxygen and Acetylene)**
American Welding Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**HOISTING MACHINERY**

**HOSE UNIONS**
Bermo Supply Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

**HYDROGEN**
International Oxygen Co.
Universal Oxygen Co.
Vulcan Process Co.

**KEROSENE PREHEATING TORCHES**
Alger Supply Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

**NEEDLE VALVES**
The Bastian-Blessing Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

# The Growth of Oxy-Acetylene Welding and Cutting and the Increasing Demand for Davis-Bournonville Apparatus

## *A Year Ago we said—*

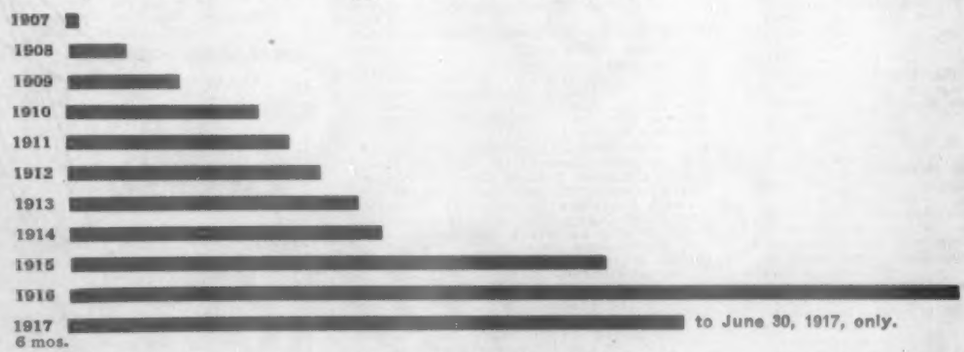
"The growth of Oxy-Acetylene Welding and Cutting in the United States is shown by the increasing use of Davis-Bournonville apparatus, which is inseparably associated with the development and success of the oxy-acetylene industry in this country.

"Ten years ago the process was unknown in the United States. Today it forms one of the great industries of the country, with its requirements for acetylene, oxygen and efficient apparatus.

"The Davis-Bournonville Company obtained the United States patents for the independent positive-pressure type of welding torch (mixing the gases in an interchangeable tip or nozzle) in 1906—basic principles which have been retained in the D-B torch because of their proven superiority through ten years of development, improvement and the most successful operation.

"There is more Davis-Bournonville welding and cutting apparatus in successful use in the United States than of any other make, and the prominent concerns which have established the greatest success with this process have large installations of D-B apparatus, with from ten to one hundred or more torch units, and from one to six of the largest acetylene generators."

*Today*—The increasing use of the oxy-acetylene process for welding and cutting and of Davis-Bournonville apparatus are parallel and are graphically shown by the sales of "Davis Apparatus" as charted below:




"Davis Apparatus" Leads the World in Range, Efficiency and Number of Successful Users. Write for bulletins and information showing why it is used by the largest steel mills, foundries, ship-yards, locomotive and car builders, U. S. Navy Yards and government works, mines, sheet metal working factories, tube and barrel welders, scrap yards, and in hundreds of small repair shops and garages.

# DAVIS-BOURNONVILLE CO.

**General Offices and Factory, Jersey City, N. J.**

| | | | | |
|---|---|---|---|---|
| NEW YORK | PITTSBURGH | | CHICAGO | SEATTLE |
| BOSTON | CLEVELAND | | DETROIT | SAN FRANCISCO |
| PHILADELPHIA | CINCINNATI | | ST. LOUIS | TORONTO, ONT. (Carter Welding Co.) |

DAVIS-BOURNONVILLE CO. DAVIS APPARATUS NEW YORK-CHICAGO

**OIL BURNERS (Preheating)**
Alger Supply Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Mach. Co.
Vulcan Process Co.

**OXYGEN (Compressed in Cylinders)**
Burdett Oxygen Co.
The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.
Vulcan Process Co.

**OXYGEN CYLINDERS**

**PIPE WELDING**
Goldschmitt Thermit Co.

**PHOTOGRAPHS**
Chicago Architectural Photographing Co., (Specialists in photographs relating to the welding industry)

**PLASTIC (Fireproof)**

**PRESSURE GAUGES**
American Welding Co.
Bastian & Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**RAILROADS—Special Service for**
Oxweld Railroad Service Co.

**REGULATING VALVES (Acetylene)**
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co., Inc.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**REGULATING VALVES (Carbo-Hydrogen)**
Carbo-Hydrogen Co. of America

**REGULATING VALVES (Hydrogen)**
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
The Prest-O-Lite Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.

**REGULATING VALVES (Oxygen)**
The Bastian-Blessing Co.
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**SCHOOLS OF WELDING**

**SEAM WELDERS (Electric)**
General Electric Co.
Westinghouse Electric & Mfg. Co.

**SEAM WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**SPOT WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**TANK CONNECTIONS (Oxygen and Acetylene Adaptors)**
Superior Oxy-Acetylene Machine Co.

**THERMALENE-GAS**
The Thermalene Co.

**THERMIT WELDING**
Goldschmidt-Thermit Co.

**TORCHES (Carbo-Hydrogen)**
Carbo-Hydrogen Co. of America

**TORCHES (Gasoline and Kerosene Preheating)**
American Welding Co.
Alger Supply Co.
Buffalo Dental Mfg. Co.
General Welding & Eq. Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Westinghouse Electric & Mfg. Co.
Vulcan Process Co.

**TORCHES (Oxy-Acetylene Cutting)**
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer Mfg. Co.
Welding Supply Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**TORCHES (Oxy-Acetylene Welding)**
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Messer Mfg. Co.
Welding Supply Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**TORCHES (Oxy-Hydrogen Cutting)**
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
Messer & Co.
Welding Supply Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Alexander Milburn Co.
The Imperial Brass Mfg. Co.
Vulcan Process Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

**TORCHES (Oxy-Hydrogen Welding)**
American Welding Co.
Bermo Supply Co.
Messer Mfg. Co.
Welding Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Vulcan Process Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
United States Welding Co.
Universal Oxygen Co.

**TORCHES (Special to Order)**
American Welding Co.
Bermo Supply Co.
The Harris Calorific Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

**TRUCKS (Cylinder Carriers)**
American Welding Co.
Davis-Burnonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

**VALVES (For Oxygen Cylinders)**
The Bastian-Blessing Co.
Universal Oxygen Co.
Vulcan Process Co.

**WELDING (Electric Resistance-Custom Work)**
Thomson Electric Welding Co.

**WELDERS' GOGGLES**
Chicago Eye Shield Co.
F. A. Hardy Co.
Vulcan Process Co.

**WELDING (Oxygen for)**
The Linde Air Products Co.
Universal Oxygen Co.
Vulcan Process Co.

**WELDING RODS**
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Steel Sales Corp.
Vulcan Process Co.

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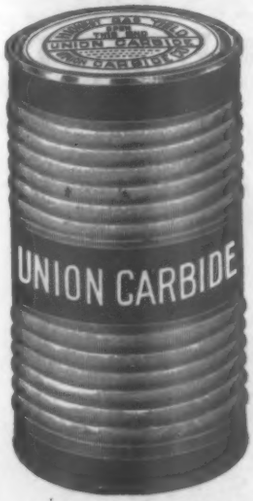


Packed in Blue and Gray Drums

# Union Carbide Sales Company

**New York City, 42nd St. Building** | **Chicago, Ill., Peoples Gas Building** | **San Francisco, Cal., Kohl Building**

*SOLE DISTRIBUTORS OF*

# UNION CARBIDE

**"World's Best Quality—Highest Gas Yield"**

## For Oxy-Acetylene Welding Plants

**Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants**

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

**3½ x 2 in.** —a large size.

**2 x ½ in.** —a medium size.

**1¼ x ⅜ in.** —an intermediate size.

**¼ x 1/12 in.** —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

**ALABAMA**
Birmingham—1916 Morris Ave.
Mobile—262-268 S. Water St.
Montgomery—114 N. Perry St.
**ARIZONA**
Phoenix—42 S. Central Ave.
**ARKANSAS**
Fort Smith—109-123 So. Ninth St.
**CALIFORNIA**
Eureka—109 Second St.
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
**COLORADO**
Denver—Nineteenth and Wazee Sts.
Victor—Third and Diamond Sts.
**CONNECTICUT**
Hartford—412 Thumbell St.
**DISTRICT OF COLUMBIA**
Washington—Maryland Ave. and 9th St., S. W.
**FLORIDA**
Jacksonville—106 E. Forsyth St.
Tampa—418 Tampa St.
**GEORGIA**
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
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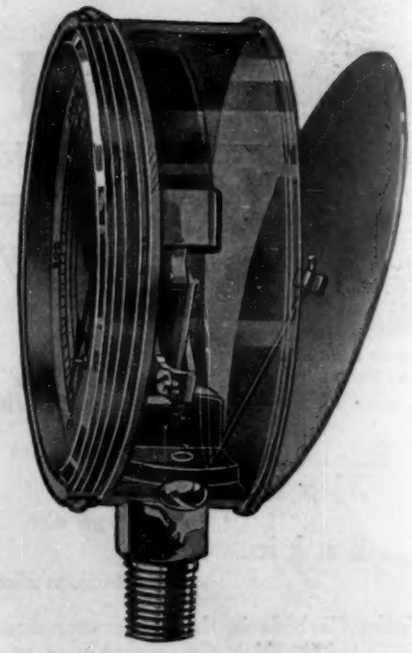

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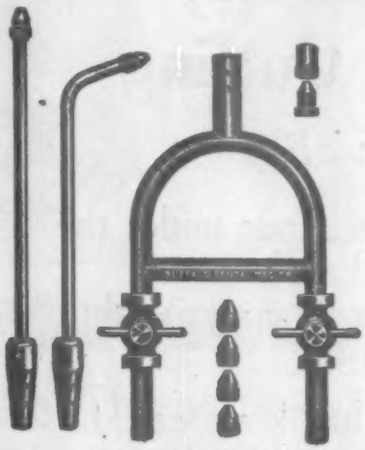

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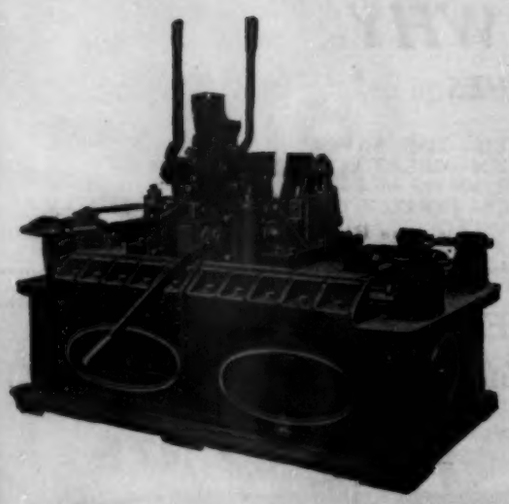
**Rim Welding Economy for the Manufacturer—**

Thomson Process Electric Welding



The 15-A Welding Machine is designed for welding heavy automobile rims. All parts are necessarily made massive and substantial in order to prevent trouble and give continuous service. The rim to be welded is placed in the specially constructed vertical clamps which are locked by a series of hand levers. Current is turned on by a pedestal foot-operated switch, and the metal becomes heated. Welding pressure is applied by the 25-ton hydraulic ram, and the current turned off. The welded rim is then removed from the clamps.

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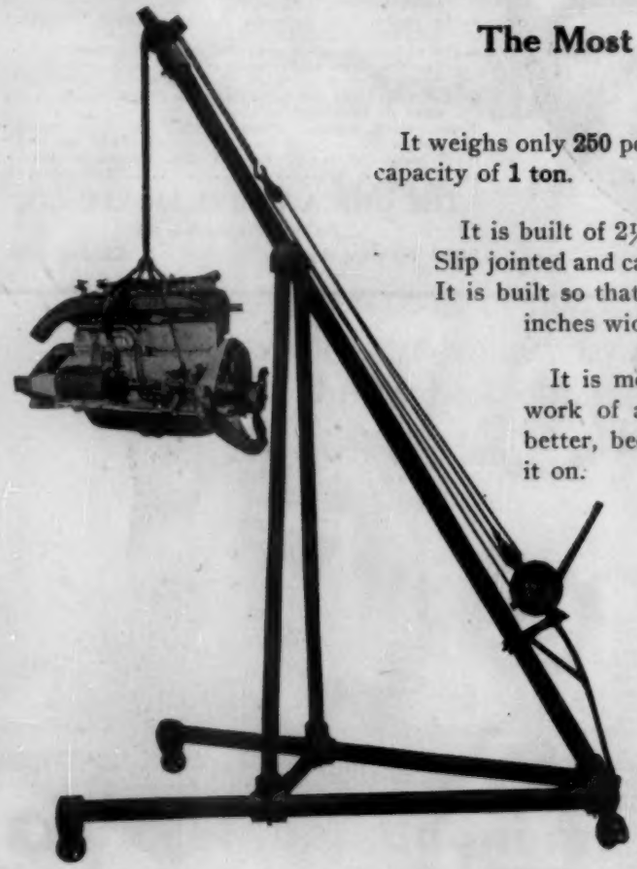
# The Pull-U-Out Portable Crane



## The Most Remarkable Portable Crane on the Market

It weighs only **250** pounds and has a lift of **9 feet 6 inches,** and a lifting capacity of **1 ton.**

It is built of 2½ inch extra heavy steel tubing, enameled black. Slip jointed and can be put together in 5 minutes with an S-wrench. It is built so that the weight cannot tip it over. Base is 3 feet 3 inches wide by 6 feet deep. Total height is 10 feet.

It is mounted on strong roller wheels, and will do the work of an entire system of overhead tracks and do it better, because it can go wherever there is a floor to roll it on.

The Pull-U-Out Portable Crane solves the problem of hoisting and transporting heavy objects from one part of the shop to another.

The Pull-U-Out can easily be detached from the crane and used separately for all manner of hoisting or pulling, making the outfit valuable in many ways other cranes are not.

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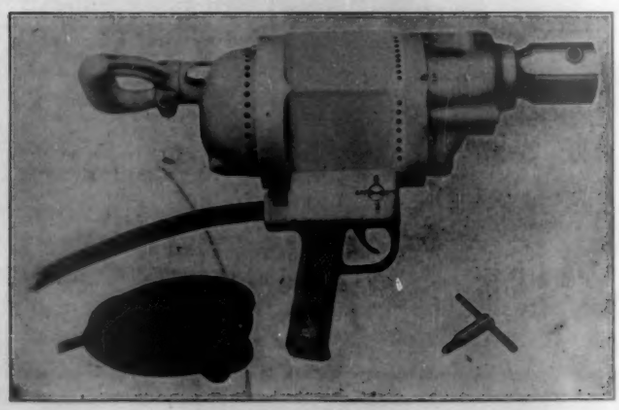
Ever try to drill a hole in some hard-to-get-at place, your wrists numbed with fatigue? And just as the drill went through, the drill bit snapped because you had to let go to reach the switch.



## The B.&D. "Portable"

### The Drill With the Pistol Grip

does away with that trouble. You keep hold with both hands and simply pull the trigger to control the current. And the pistol grip holds the "gun" naturally and easily. Universal motor, ball thrust bearing, chrome-vanadium steel gears. Welders will find this tool well adapted to work in the welding shops.

### SAVES DRILLS

In designing this model, especial attention has been directed toward the prevention of breakage of small drills when operating the switch (a source of annoyance and loss with other designs.)

It will be seen, by reference to the illustrations, that the control is that of the automatic pistol, one finger doing the work without in the slightest affecting the steadiness of the aim or the firmness of the support of the tool. There is no releasing of the grip to turn the switch or press a button, or push in or pull out a handle at the moment the drill breaks through.

You simply pull the trigger without the slightest wavering of the tool or sagging of the weight, and consequently the drill is stopped without breaking the drill bit.

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# "Armco" Iron Welding Materials

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The illustration shown above is one of the most striking examples of the practicability of welding. The cylinder was constructed for use in connection with a Diesel engine. Armco Iron welding rods joined the seams so perfectly that a tremendous hydrostatic pressure test of 3,000 lbs. to a square inch failed to reveal any weakness.

The outstanding qualities of "Armco" Iron welding rods are purity and ductility, so essential to successful welding.

Welding Quality was one of the five Special Characteristics for which "Armco" Iron was awarded the Grand Prize at the Panama-Pacific Exposition.

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Other sizes can be manufactured

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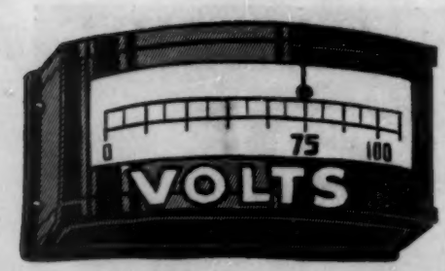


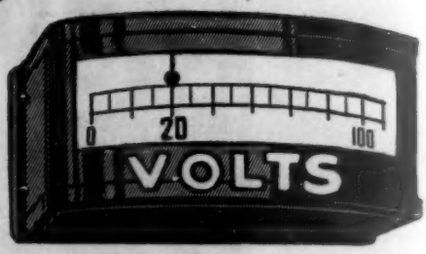


# Lincoln Arc Welders

## Will Save Money

Arc welding requires an *average* voltage of about 20 volts. When the welder delivers any voltage above this amount it must be cut down to the proper voltage by resistances and the excess power represented is thus wasted.

Lincoln Arc Welder is a *variable voltage* machine, delivering at all times the exact voltage needed at the arc.

No resistances are used in circuit—and no power is thus wasted. Since there is no resistance no complicated clapper switches or solenoids are necessary so that any workman can operate the machine without the assistance of an electrical expert.

*We are ready to show Lincoln savings over any other equipment by a test in your own shop.*

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Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

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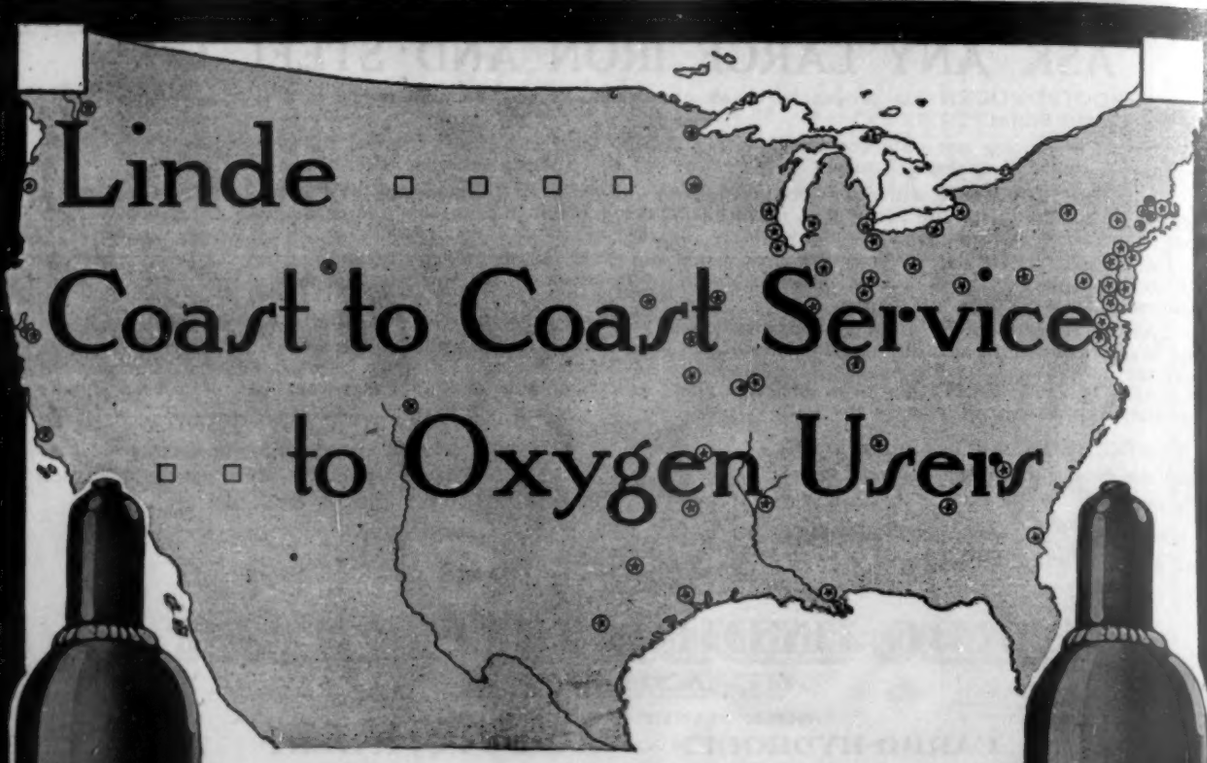

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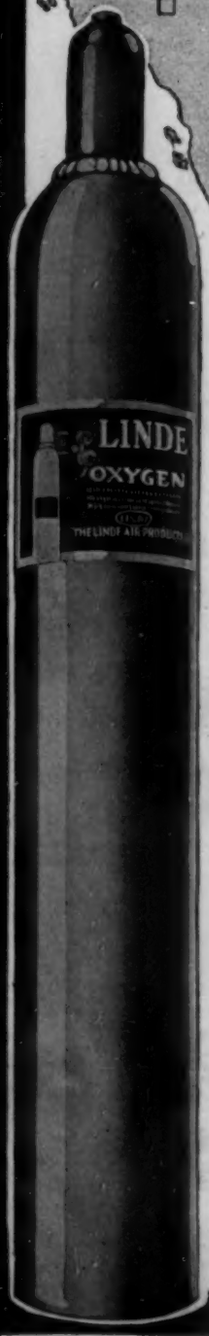

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# OXY-ACETYLENE WELDING *of* COPPER, BRASSES *and* BRONZES—III

*By* M. R. Amedo

*Metallurgical Engineer to the Union de la Soudure Autogene. Translated, with additions, by D. Richardson, Wh. Exh., A.M.I. Mechanical Engineer, Member of the Union de la Soudure Autogene.*

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**The Use of Asbestos.**—When welding thin sheets of copper and even plates of medium thickness, it is advisable to place under the lines of welding, and, in the case of thicker material, at the sides, an insulating material, such as, for example, asbestos. If this precaution is not taken, a considerable thinning of the material takes place in the region of the weld, due to the sinking of the metal.

The asbestos may be used in the form of sheets or millboard. The disposition of the asbestos in the case of plates is shown in Fig. 7, and in the case of tubes or pipes in Fig. 8. In the former, A is the plate bevelled and placed

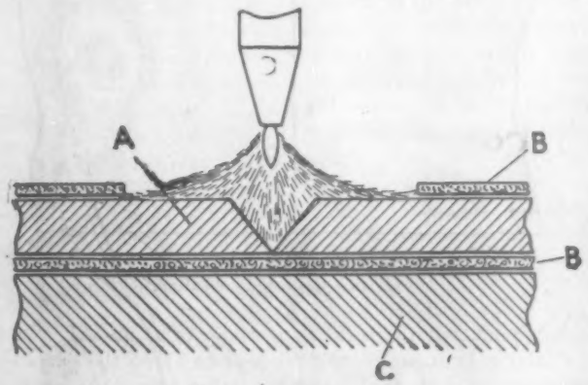


**Fig. 7.—The Use of Asbestos.**

on a sheet of asbestos B, which in turn is placed on a slab of firebrick or other similar material C. Absteos is also placed on either side of the lines of welding as shown at B. In welding tubes or pipes, a layer of asbestos is arranged on a mandrel or tube and placed under the line of welding as shown in Fig. 9, where A is the tube and C the mandrel covered with asbestos B. This simple arrangement can also be used in the welding of plates.

It is advisable, before commencing to weld, to play the blowpipe over the asbestos which will be in the vicinity of the under side of the weld. This precaution avoids the formation of numerous blowholes on the under side of the weld, as commercial asbestos always contains organic materials and moisture.

**The Power of Blowpipe.**—It is important to use the right power of blowpipe, a blowpipe of too small a power produces the defect of adhesion, as also does the use of too large a power blowpipe. The blowpipe to be used for a weld on copper which has been uniformly preheated to a light cherry red (1,550° F.) should be equal in power to the one used for welding the same thickness of iron or steel.

It is, perhaps, necessary here to explain exactly what is meant by the power of blowpipe. The power of a blowpipe, in other words, the quantity of heat which it is capable of giving out in a given time, is universally measured by the number of litres or cubic feet of acetylene burnt in an hour with the flame perfectly regulated. This number is usually supplied by the maker, and is sometimes marked on the blowpipe. In default of knowing this number the welder can approximately find the power by measuring the diameter of the hole in the nozzle.

A good practical rule in welding iron or mild steel is that for every ⅛-inch in thickness the hourly consumption should be 240 to 320 litres or 8½ to 11 cubic feet.

The following table gives the figures for a few thicknesses and the approximate diameter of the hole in the blowpipe nozzle.

**Power of Blowpipe for Mild Steel**

| Thickness of weld in inches | Consumption of Acetylene per hour In Litres | In Cubic Feet | Diam of Nozzle Orifice in 1-64th ins. |
|---|---|---|---|
| 1/16 | 120 to 160 | 4¼ to 5½ | 3 |
| ⅛ | 240 to 320 | 8½ to 11 | 3 full |
| 3/16 | 360 to 480 | 12¾ to 16½ | 4 |
| ¼ | 480 to 640 | 17 to 22 | 5 |
| ⅜ | 720 to 960 | 25½ to 33 | 6 |
| ½ | 960 to 1280 | 34 to 44 | 7 |
| ⅝ | 1200 to 1600 | 42½ to 55 | 8 |

The power of blowpipe as fixed by the above figures is applied to average welds; obviously it would be reduced if the length of the weld is small.

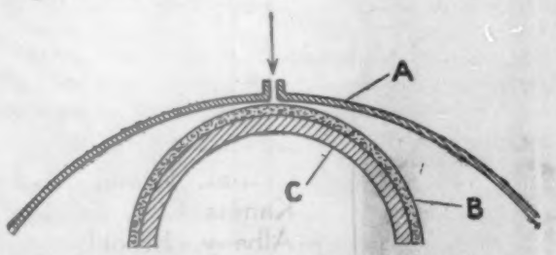


**Fig. 8.—Mandrel Coated with Asbestos, Used in Copper Pipe Welding.**

**The Position of the Blowpipe.**—The blowpipe should be held almost perpendicular to the surface of the work so as to avoid driving the molten metal along the bottom of the chamber.

The white cone of the flame should never be dipped into or come into contact with the molten metal. It should be kept at about a distance of a quarter of an inch from the molten metal. If the heating is done under proper conditions, the melting of the edges of the weld and their mixture with the welding rod should be produced freely without any fear of overheating the lines of welding.

Some welders execute copper welds by welding "backwards" or towards them; this method of working is bad

as it prolongs the overheating of the metal and consequently facilitates the cracks due to contraction.

**Diameter of Welding Rod.**—The section of the welding wire for work on thin material should always be much greater than in the case of welds on iron and steel. Even in the case of very thin material, the wire should have a

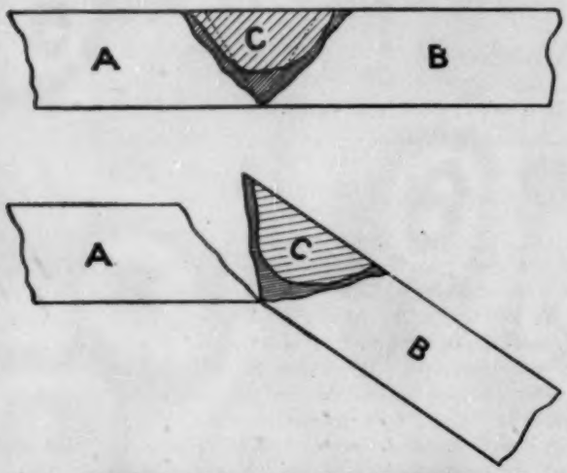


**Fig. 9.—"Burning" and Separation Along the Chamfered Faces.**

minimum diameter equal to 14 gauge. If the wire is too thin it burns under the action of the blowpipe. As mentioned previously, the use of a welding wire of too large a diameter has the same disadvantages as using a welding wire containing too much phosphorous.

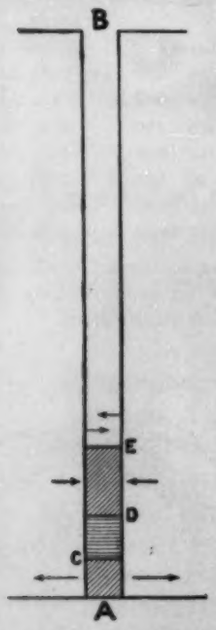


**Fig. 10.—Contraction Effects.**

Here is a table giving the sizes of welding wire suitable for welding plates of various thicknesses.

| Thickness of Plates. | Diam. of Welding Wire. | Thickness of Plates | Diam. of Welding Wire. |
|---|---|---|---|
| Gauge 20 | | 1/8 inch | Gauge 5 |
| Gauge 19 | Gauge 16 | 3/16 inch | Gauge 3 |
| Gauge 18 | | 1/4 inch | |
| 1/8 inch | Gauge 15 | 1/2 inch | Gauge 2 |
| 1/6 inch | Gauge 12 | 1/8 inch | |
| 1/8 inch | Gauge 9 | 3/4 inch | Gauge 0 |
| 1/4 inch | Gauge 6 | 3/4 inch | |

It should be remembered that in welding copper the sizes of welding wire given in the above table should be increased for the case of thin plates and, as already mentioned, welding wire under 14 gauge should not be used.

**Flux.**—Theoretically it is not necessary to add a flux for the welding of copper. However, if the edges become dirty from any cause whatever during the welding operation, it is advisable to use a flux. It is also necessary to use a flux on repairs or old material. The flux is the same as that used in welding brasses and bronzes which will be dealt with later.

**Burning the Bevelled Faces of Welds.**—Very frequently the welds are simply glued along the bevelled faces, even when the heating has been carried out in a normal manner. This very serious defect in copper welds indicates defective work.

*It is important that the welder should remember never to melt copper without the welding rod is present at the same time. The penalty for lack of this precaution is a heavily oxidized weld, or a "burnt" weld in the true sense of the word.*

If a welder commences to weld copper by allowing the metal from the faces of the bevelled edges to fall in and partially fill the joint, he obtains as a result, a layer of burnt copper, of no value from the mechanical point of view. The metal added afterwards in the central part C (Fig. 9) is

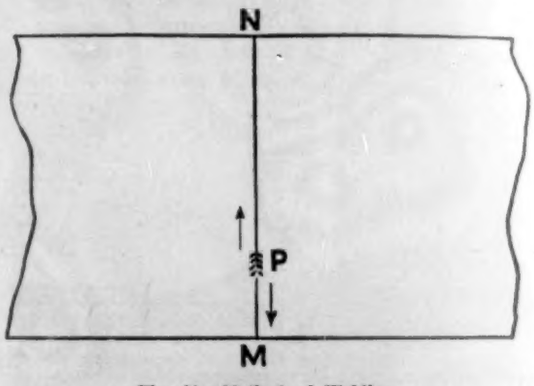


**Fig. 11.—Method of Welding.**

quite sound, but the weld as a whole is of no value, and if the joint is bent, separation takes place along the burnt edge as shown in Fig. 10. An examination along the separated edges reveals very large blowholes which would not be present in a weld executed with the phosphorous-copper.

Such methods of work nullify the use of a metal containing a deoxidizer. The melting of the bottom of the weld or the bevelled faces should be progressive and always accompanied by the melting of the welding-rod, which, having once been placed in the joint, should remain until the same is complete.

It is just as defective to go over a part just previously welded without a new addition of metal capable of preventing oxidation.

**Contraction Effects.**—It is necessary to take precautions to avoid cracks or fractures due to contraction. The cracks or fractures which take place in welds of great length are generally due to two causes:—

(1) The low strength of the cast copper which constitutes the joint.

2) The reduction of this strength, even in portions some distance from the parts attacked by the blowpipe, by the high temperature effect of the blowpipe.

The methods of avoiding such fractures are:—

(1) To avoid or diminish the result of contraction.

(2) To increase the strength of the welded parts.

It seems difficult to realize the first of these conditions. It is, however, often possible to diminish the forces tending to fracture the metal during the course of welding.

Suppose, for example, it is a question of welding the seam of a copper pipe or even a straight weld (Fig. 10). The pure and simple execution of a weld on plates placed edge to edge inevitably leads to failure. A necessary preparation of the weld consists in separating the edges at B by an amount equal to 5 or 6 per cent. of the length AB. Again, suppose the melting of the metal has reached E say, the portion DE rapidly solidifies with intense contraction effects. The portion CD behind DE being much cooler, the contraction is considerably less. The effect of the drawing together of the plates at DE is a tendency to

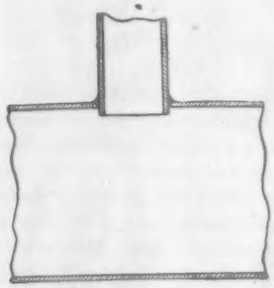

Fig. 12.

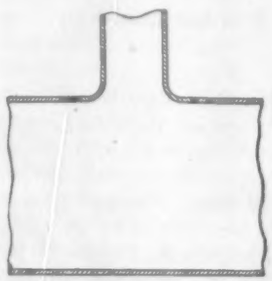

Fig. 13.

lever open the plates at AC, the one CD acting as a fulcrum or pivot.

The bursting open of the plates at A is almost inevitable and a crack once started extends as the weld proceeds. If the point A is made very strong, the crack will take place in the welded lines during solidification and in the zone DE. The most simple method of avoiding cracks or fractures due to this cause is *never to commence welding at the extremities of the plates.* Suppose, for example; the seam MN (Fig. 11) is to be welded. The weld is commenced at some point P and welded towards N, the movement of the free ends at M about P as a pivot can be very clearly seen. Having completed the portion PN, it is a simple matter to weld the remaining portion PM, which is welded, needless to say, in the direction P to M.

The welding of patches or pieces on to tubes or pipes is

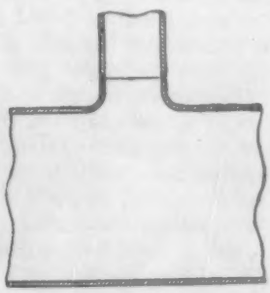

Fig. 14.

frequently met with in copper welding, and the piece should be uniformly stamped to a radius of curvature distinctly smaller than the tube or pipe, in other words, the convexity is more pronounced. The construction stretches the piece, and a fracture is prevented, which, without this preparation, is inevitable.

In welding branches on to tubes or pipes, the preparation shown in Figs. 12, 13 and 14 are adopted.

Fractures are almost sure to take place if the methods shown in Figs. 12 and 13 are adopted, because the contraction effects are different in the two tubes and the line of welding is too extended. The preparation shown in Fig. 14, where a flanged collar is formed on the larger tube, is the most satisfactory. In order to avoid cracks or fractures when the plates are worked in any way, it is necessary, as previously mentioned, to increase the tenacity of the copper in welded parts. The treatment which copper welds should undergo in order to increase their mechanical properties are always the same, no matter whether it is a question of simple end to end welds on bars or the welding of plates.

**Hammering and Annealing Copper Welds.**—Assuming that the welds are sound, in other words free from oxide and blowholes, the metal in the joint and its immediate neighborhood is always in the cast condition, especially in the case of welds on thick material. The metal consists of very large crystals which are developed as a result of the high temperature reached by the metal in the vicinity of the molten zone.

The tensile strength of cast copper is about 20,000 pounds per square inch and its elongation is very small. By forging the copper, that is to say, by vigorously hammering the lines of welding and their immediate neighborhood, a metal with a much higher tensile strength is obtained. The tensile strength is raised to over 33,000 pounds per square inch, and the elongation is from 25 to 30 per cent. If these figures are compared with the figures for rolled copper plates, cold hammered and annealed, which have a tensile strength of 27,000 to 37,000 pounds per square inch and an elongation of 22 to 40 per cent. (the maximum elongation corresponding to the maximum strength), it will be recognized that hammering is an excellent operation to apply to welds, giving them a strength sufficient for all practical purposes.

The hammering may be done hot for bars or very thick copper, but copper should not be hammered at too high a temperature.

After the hammering is completed it is advisable to anneal the copper by raising it to a red heat, and, where possible, plunging it into cold water or cooling off as rapidly as possible. The rapid cooling of copper, reheated to a temperature of 500 to 600°C (932° to 1.112°F.) greatly improves the metal that has been overheated. The surrounding parts of a weld which has been hammered, annealed, and rapidly cooled, no longer consists of large crystals; the fragility of the whole joint is diminished and becomes tougher.

When working on a weld of great length it is advisable to execute the weld in sections which are afterwards uniformly heated and submitted to hammering whilst hot, followed by a new re-heating and then cooled off with water. Welds carried out in this manner can be worked or stamped without difficulty.

**Mechanical Properties.**—Practically, a weld on copper hammered and annealed, can be relied on to have a tensile strength of 33,000 pounds per square inch, and an elongation of 22 to 25 per cent.

If these values are compared with the specification figures of the railway companies, etc., in purchasing copper, in which for example, a minimum tensile strength of 28,500 pounds per square inch and an elongation of 35 per cent. are required, it is obvious that the results obtained in welding copper are satisfactory enough to permit the application of oxy-acetylene welding for the construction of a large number of articles at present riveted or brazed.

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# WAR *and* WELDING*

## *The Author Believes Both Electric and Gas Welding Processes are Proving Themselves One of Our Strongest Allies, at Home and at the Front*

*By* E. W. Wanamaker,
*Electrical Engineer, Rock Island Lines.*

In addressing the Western Railway Club on the subject of operating economy, I feel that it is entirely unnecessary to enumerate the reasons why it is necessary for the railway systems of the country to exert the maximum effort to move the freight of the country with the greatest possible dispatch. That is a lesson which we have learned as the result of the campaigns which have already been fought in Europe. We have the example of the remarkable effectiveness in transportation which has been reached by Germany, and, on the other hand, have witnessed the most complete failure of the Russian military effort, due to lack of proper transportation facilities. The paper presented to this club on September 18th by Mr. W. L. Park, Vice-president of the Illinois Central Railway Company, together with the discussion following it, deals with this subject in a very excellent manner.

So far as we can see at present, the railroads of the country will not be burdened as seriously, due to the necessity of transporting the armed forces of the nation, as they will be burdened with the transportation of food for the seaports, and the multitude of commodities, which requires transportation, to be manufactured into munitions of war, and which later must be delivered to a seaport for ocean transportation to the theater of war. This latter transportation service is in no way different in quality from the ordinary industrial transportation service which the carriers must render in time of peace. However, there is an enormous difference in the quantity of service required. The effectiveness of the nation in the war is a function of the time required to put effective fighting units in the field and keep them properly supplied with food and the implements of war. The ability of the railroads to meet the demands upon their transportation facilities will be an important factor in the time required for the nation to become effective on the battle fronts.

This discussion deals with one way of getting more transportation service out of the railway equipment in existence at the present time. Efforts spent in this direction are as patriotic and necessary as can be imagined. I do not wish to depreciate for a moment the patriotism of the man who puts on the uniform and risks his life "to make the world safe for democracy." I do insist, however, that the patriotism of the civilians, particularly of the mechanical engineers in railway service, must not stop with the more or less superficial demonstrations of loyalty to the stars and stripes. Those of us who cannot go to the fighting front must use the best of our abilities to get service, "and still more service," to paraphrase Lloyd George's quotation, from the motive power and rolling stock of the nation's railway systems.

The growing possibilities of the welding processes in motive power and rolling stock maintenance have been a source of amazement to every railway man who has come in contact with the practice. From an engineering standpoint, the welding processes are particularly interesting. In the matter of cutting metal the improvement in practice brought about by the introduction of the oxygen torch is particularly great. Only a few years ago the shearing of plates was the only method used for cutting plates, etc., to the proper size for manufacture and repair purposes. It was slow, inaccurate, and wasteful. The cutting of large holes and special shapes after the plate had become a part of a boiler or machine had to be accomplished with drill and chipping hammer. The cutting of rivet heads, bolts and nuts was an operation which took an unreasonable length of time and required an expenditure of labor all out of proportion with the results accomplished. In such operations the application of the oxygen cutting processes saved from 50% to 90% of the time required to perform the operation. Yet I regret to state that in many of our locomotive shops and car yards the old practices are still followed and our man power for this cause has not produced the maximum result.

The matter of fastening two pieces of metal together is one of the fundamental problems of mechanical engineering, since all machines are made up merely of so many pieces of metal fastened together. The rivet is almost as old as the hammer and anvil. The threaded bolt and nut, as compared with the rivet, are recent inventions. The welded fastening came down to us from antiquity. The welded fastening has always been looked upon as a stronger joint than the riveted or bolted fastening. The reason that it was never more widely used until recent years has been due to the fact that only one way of making a welded joint was known, and that this was not applicable, except to a limited range of joints. As a general proposition the riveted joint, or bolted joint, has a tensile strength which is considerably less than the tensile strength of the original piece, while the welded joint is as strong as the original section. For instance, two pieces of boiler plate may be riveted together with four rows of rivets and double straps, and the tensile strength of the joint will not exceed 85% of the strength of the original plate, yet it is quite a simple matter to weld a joint in the same plate, either by the old forge welding processes or by later autogenous welding processes, and obtain a joint that is as high in tensile strength as the original plate. The reason more of such welded joints have not been produced prior to the introduction of the autogenous welding processes has been due entirely to the difficulty experienced in applying a forge weld to the vessels made of plate. The welded joint, and particularly the butt welded joint made by an autogenous welding process offers greater strength, with a thickness for practical purposes equal to the thickness of the original plate. This is a feat in mechanical engineering which has been unheralded, but ranks with the introduction of the power hammer, the pneumatic tool, and other great strides in mechanical engineering progress.

There was a time when worn surfaces of the steel parts in a machine made it necessary to scrap those parts. There was no method, aside from the using of chafing plates, of avoiding this practice. The wearing of a fraction of a cubic inch of metal from one of the wearing surfaces of a steel part made it necessary to scrap the labor investment in that particular part entirely.

*Paper read before the Western Railway Club, Sept. 17th, 1917.

It was only with the introduction of the autogenous welding processes that it became possible to stop this economic waste. This also ranks as an important engineering achievement, and it has only been in the last three years that the possibilities in this direction have begun to be realized. While it has not been possible to apply this salvage to cast iron parts to any great extent, the tendency has been towards the introduction of steel castings in place of grey iron castings to accomplish the desired result.

The repair of broken members of a machine has been another important work of the autogenous welding processes. Prior to their introduction certain steel parts could be welded in the forge fire, but the range of the work was very limited and in many cases its cost equal to the cost of a new part. Now, however, with the exception of cast iron parts, the failure of which would bring death and destruction, practically all parts of a machine which break may be safely repaired.

Viewed from the perspective of the last fifty years, the achievements made possible by the autogenous welding processes in the last five years are probably the most remarkable of any in the mechanical field. It is my purpose to point out so far as is possible how far these new practices may be utilized on steam railways to enable the railway systems of the country to meet the present emergency in the matter of service demanded from motive power and rolling stock equipment. It seems advisable to preface my remarks on the newer processes with a short discussion of their relationship to the other and more established practices.

Forge welding has probably been practiced ever since man had intelligence enough to construct a crude anvil and a hammer. It rests on the fact that when two pieces of iron are raised to such temperature that they become plastic, they may be forged together and will become, at the junction, a homogenous mass. The art of forging depends upon three things:

1. The surfaces which are to be welded together must be clean so that the molecules of iron may come into intimate contact during the operation.
2. The temperature of the metals must be such that cohesion of the molecules may take place, but must not be high enough to depreciate the physical properties of the metals.
3. The mechanical pressure must be applied in such a manner as to bring the molecules into such intimate contact that cohesion will take place.

The first of the new welding processes, which may properly be called autogenous processes, since the welding takes place more or less automatically, was the thermit welding process. In this process the metals to be welded, together with the additional quantity of metal of approximately the same composition, are heated to a liquid state by a chemical reaction, so that cohesion takes place while they are in the molten state, *without the mechanical pressure*. This process found a wide application in the repair of broken steel parts on the railroads and the saving which resulted from its use, without doubt aggregated millions of dollars.

Welding with the oxygen and fuel gas flame was the first widely used autogenous welding process. In this case the heat for welding is produced by the chemical union of oxygen and some fuel gas, such as acetylene. The gas flame as a tool in the railway shop is best described by the once fictitious term, "putting on tool." The parts to be welded are heated to a liquid state at their surfaces by the heat of a flame and the metal to be added is melted simultaneously. The union, or fusion, takes place and the metal in the joint cools off, leaving a homogenous mass which we call a weld. Since everyone is more or less familiar with the gas welding process, this paper will deal primarily with the electric welding process and an extended discussion of the gas process will be omitted. It is sufficient to state that at the present moment the essential difference is in the method of producing the heat for welding, rather than in the fundamental principles involved.

In passing, it may be stated that there is a form of electric welding which is not an autogenous method of welding, but which is increasing in prominence in railway work. I refer to butt or spot welding work. In these processes both heat and pressure are used to produce the weld. The heat is produced by the resistance offered to the passage of an electric current through the pieces to be welded. The temperature is raised to the point at which the metals become plastic and the pressure applied. In principle the processes are identical to the forge welding process. Butt welding as applied to the safe ending of flues offers an attractive saving and will undoubtedly become standard practice on all railways in the near future.

There are two kinds of electric arc welding, known respectively as carbon electrode welding and metal electrode welding. In the former an arc is drawn between a carbon electrode and the piece to be welded and the metal to be added fed into the arc in the form of a "melt bar." This process is not used extensively in railway work, due to the fact that welding may only be done in the horizontal plane in this manner and that the work is in general inferior to that which is possible with the metal electrode process.

The metal electrode process uses, as the name implies, a metal electrode,—the arc being drawn between the electrode and the piece being welded. The heat of the arc melts the metal of the piece and the metal of the electrode simultaneously. As the metal of the electrode melts it is drawn across the arc to the molten metal of the piece where a complete and homogenous union is form, which we call an autogenous weld. I say the metal of the electrode is *drawn* across the arc rather than that it falls through the arc advisably, since it will flow straight overhead as well as straight downward. The temperature of the arc is extremely high at its center, actually vaporing the metal to form the visible arc. With the exception of work with certain electrodes (managanese steel and slag-covered electrodes), the electrode is always made the cathode or negative—that is, the current of electricity flows *from* the piece being welded to the metal electrode. The reason for this practice is that the greatest amount of heat in an electric arc is liberated at the point at which the current passes from the solid medium to the heated vapor of the arc. Since the metal of the piece has more mass and conducts the heat away from the point at which the welding is being done more rapidly than the electrode, it is desirable to have the greatest amount of heat on the piece. Due to the composition of the manganese and slag-coated electrodes, it is necessary to make these electrodes the positive.

The characteristic of the wire which is used for the metal electrode is an important matter. A dead soft steel wire has been found entirely satisfactory for this work. Not all dead soft steel wire, however, works well in the arc. Uniform mechanical treatment in manufacture and careful annealing are required to secure the best results. This wire can be secured at the present time at a cost ranging from approximately 6 to 10 cents per pound. Good welding wire may be relied upon to give metal in the weld which has a tensile strength of from 50,000 to 55,000 pounds per square inch. The deposited metal is very soft and easily machined, although it is without appreciable elasticity. When properly deposited, the metal is practically free from blow holes and slag inclusions, although a certain amount of oxide in solution is unavoidable. Except for the absence of elasticity, the deposited metal is of the nature of cast steel.

The voltage required for metal electrode welding is approximately 20 volts and direct current power is necessary. The various types of welding equipment are merely different plans for rendering available a rather heavy current at this voltage, and the power economy of the several systems for obtaining this result varies over a wide range. Since we have gone into the matter on a rather extensive scale on the Rock Island Lines, it may be of interest to analyze briefly the conditions which led us to decide on a certain type of equipment.

A little over five years ago, the Rock Island installed four electric welding units of the first type that had been manufactured in this country. During the time since their purchase, and up to the present, we have been quietly investigating and developing our electric welding practice. As a result, we found that to obtain a suitable welding system it was necessary that we secure a light, compact, portable unit, of few parts, and of extreme simplicity, which would be entirely free from complicated mechanical regulating devices.

In planning the installation, a careful analysis was made of the service which is demanded of electric welding equipment in railroad shops and engine houses, and an attempt was made to design an installation which would show, under such conditions, maximum reliability and flexibility with minimum installation and operating expense. It appeared certain that the welding process would find a wider field of application than was apparent at that time, and the installation was made in such a manner as to lend itself readily to enlargement should that become necessary. And I might say here that in view of our experience and results we were indeed fortunate in rendering an expansion of the welding facilities easy. The lack of standardization of operations in the practice at that time made it extremely difficult to predict accurately the size of installations which would be required at the various points on the system, so it appeared desirable to install equipment which could be moved from one point to another, until proper distribution could be obtained.

It was considered particularly desirable to have the arc welding equipment available at all points in the shops and engine houses, since it was quite evident that the advantage of the low cost of the arc welding process would be lost if, for instance, the locomotive had to be moved from a haphazard location to a point where the welding power would be available. These features led to an analysis of distributing systems for the welding power and showed the necessity of using portable arc welding equipment, similar, so far as possible, to the portable gas welding outfits. With the total capacity divided at each shop among several units, it appeared certain that so long as power was available, there would not be a complete shutdown of the welding equipment. Each operator would be entirely independent of the others, although as many as necessary could be concentrated on any engine or job in the shop.

The operating economy, while not a deciding factor, was important, since at some shops the power plants were loaded to their capacity, and at other points the power purchased from small central stations was rather high. Under these conditions, the variable voltage type of equipment was considered the best because this type eliminated the resistance ballast from the arc circuit, thus increasing the power economy of the units to such a degree that a single operator unit may be operated from a power line large enough to carry a five-horsepower motor.

As a result of the analysis of the requirements of the shops and car repair yards, 33 individual unit welders were installed, 10 of which were mounted on brackets on columns in the largest locomotive shop, while the other 23 were portable machines weighing complete with truck approximately 1,700 pounds. All of these units are motor generators having inherent regulation and an arc stabilizer. The portable units are equipped with ball bearings which require lubrication about once in six months. Part of the machines are equipped with 230-volt direct-current motors and part with 440-volt three-phase, 60-cycle motors, these two kinds of power being the standard on the Rock Island Lines.

I might say in passing that at the time we purchased the portable equipment the manufacturers of the welding outfit were only able to furnish a standard industrial truck for this purpose. We have since found from actual practice exactly what is required in this line and are developing a standard truck which meets the requirements much better than an ordinary industrial truck. One of the manufacturers will shortly offer this development on the market as standard equipment.

The portable unit system was found to be from 30% to 40% lower in total initial installed cost due to the elimination of the low voltage distributing system.

With a system such as has been installed on the Rock Island Lines, with portable welders, the installation of electric welding equipment is converted into a system proposition rather than a series of plants to take care of certain shops or terminals. The plan is extraordinarily flexible and has many desirable features that would be impossible to obtain with any other plan or type of equipment. For instance, if it is found that one or more welders are needed at some shop, it is very probable that some can be transferred from another point which has more than can be used to advantage at that particular time, it is only necessary to pull the units to be transferred into a car, block them substantially, and bill to the point where needed. Immediately on receipt they are ready for operation. We have taken advantage of this feature of the plan on a number of occasions and have been able to relieve congestion of work and get engines into service considerably ahead of the time originally estimated. However, officials at all points are very reluctant to surrender any of their welding equipment, claiming that they have not nearly enough as it is.

We have succeeded in making the application of the electric arc welding process on the Rock Island Lines a system proposition not only in the matter of the apparatus itself but also in its operation. It appeared to us that some roads were using the process in a more or less haphazard manner, leaving the matter to the fancy of the operator. It seemed to us that in going into the practice it would be advisable to throw the whole force of the operating organization into it to get the most out of it. The successful application of the process requires the combination of three factors—engineering knowledge, craftsman's skill, enthusiasm. The direction of the practice on our road rests with the engineering staff of the mechanical department; the actual operation is done by skilled members of the boilermakers', pipefitters', machinists' and blacksmiths' crafts. We do not employ novices or apprentices in this work. Only the best men of the respective crafts are picked for operators. It has been plain from the start that only the highest type of craftsmen could secure the results we want and we have witnessed the growth of a considerable amount of pride and enthusiasm in the work among our skilled craftsmen in this work, whereas I am quite facilities for welding, we recognize the fact that it is absolutely necessary that only skilled operators be employed.

Under competent direction, the skilled and enthusiastic operator will seldom make serious blunders in the application of the process. We have found few of the "know it all" type of men among our skilled craftsmen in this work, whereas I am quite certain some roads have had great difficulties in this line among operators made of green apprentices and "handy men." Further, we have found that the skilled craftsman, who is enthusiastic about the process, is continually finding new and profitable fields for its application.

The connecting link between the engineering staff and the operators is the Supervisor of Welding, who is fully informed on the range of approved applications and is also the most expert operator on the road. He is continually traveling between the shops keeping the practice of each up to date and seeing that everything runs smoothly. The operators at local points are under the supervision of the foremen and master mechanics in exactly the same manner as lathe operators or other craftsmen.

Due to the shortage of time, it is not within the scope of this paper to discuss in detail the necessary instructions for properly operating a complete welding system. On the Rock Island it was found essential that we compile a complete set of welding instructions, which comprise some thirty typewritten pages. It is the purpose of this set of instructions to standardize the major operations as far as possible. The extreme range of the application of the process has made it quite impossible, up to the present

time, to standardize every single operation, but these instructions cover the field in such a general way that the operator is prevented from making serious welding blunders. In view of the fact that our practice has been so rapidly developed by this method, it will be necessary, this Fall, for us to revise and reprint our standard welding instructions, which at that time will be very complete. Let it suffice to say that the ability of the operator to make good welds requires that he have some knowledge of metals and their properties, especially as regards expansion and contraction, and that his education by the supervisor be thorough and complete. It is now evident to us that the complete instruction and training of the craftsmen in the art of electric welding should be considered as a necessary additional course to the apprenticeship they served when learning their trades, in order to keep pace with the rapid strides being made today in mechanical engineering practice. It is the desire of the writer and the intention of this paper to more fully acquaint the railway management with the economic value of the new welding process, both in war and in peace, in order that it may be given the great attention that it so well deserves.

The actual results of the operation of the welding equipment and the welding system on the Rock Island Lines have proven very interesting. We have recently undertaken a rather extensive investigation of what the results are, and I am giving below some of the figures we have obtained as a result of about six months' operation of the complete system. The real answer to the question of whether or not the expenditure of some $40,000 for the installation of the system was justified lies in the actual facts—reduction of maintenance cost and actual gain in engine days with our present equipment. In other words, the object of the investigation was to determine whether or not we are saving money by the operation of the system, and whether or not we are actually getting more transportation service out of our motive power and rolling stock equipment. The following table shows some actual figures on the cost of repairing a small number of representative locomotive and other parts (for which we were able to obtain costs at a reasonable expenditure) by the gas and electric method, as compared with the old method, which in many cases involves a complete replacement of the part. It is indeed unfortunate that the railways have not kept detailed costs of the work necessary to the operation of the property. As compared with the old method, the saving of the electric process arises principally in the saving in labor. As compared with the gas process, the electric welding offers a saving in cost of producing heat and an appreciable saving in cost of labor. It seems to me that under present conditions, and possibly under conditions which will obtain in the future, the labor saving is the most important item. It is evident from the figures that an important saving has been made. In other words, the operation of the process in our shops may be said to have rendered each man more effective, and has enabled each man to accomplish more towards the maintenance of our equipment with the same amount of effort. It seems to me that in view of the present labor conditions, which involve principally the very serious shortage of skilled labor, this is quite an important matter.

COMPARISON OF ELECTRIC WELDING VS. OLD METHODS AND GAS WELDING

| Description of Parts | Cost Old Method | Cost Gas Welding | Cost Elec. Welding | Saving Over Old Method | Saving Over Gas | No. Engs. |
|---|---|---|---|---|---|---|
| Valve stems | $ 16.28 | $ 15.26 | $ 4.76 | $ 11.52 | $ 10.50 | 6 |
| Eccentric straps | 17.96 | 7.63 | 2.38 | 15.57 | 5.25 | 2 |
| Cylinder cocks | 1.36 | 1.04 | .34 | 1.02 | .70 | 1 |
| Cross heads | 356.40 | 120.23 | 37.73 | 318.67 | 82.50 | 13 |
| Piston heads | 47.92 | 32.74 | 10.24 | 37.69 | 22.50 | 4 |
| Motion saddles | 8.32 | 10.94 | 3.44 | 4.88 | 7.50 | 2 |
| Frame braces | 99.50 | 48.00 | 15.00 | 84.50 | 33.00 | 10 |
| Crank arms | 18.81 | 26.14 | 8.14 | 10.67 | 18.00 | 5 |
| Rocker box castings | 4.59 | 7.29 | 2.04 | 2.55 | 5.25 | 1 |
| Transmission bar | 2.80 | 4.38 | 1.38 | 1.42 | 3.00 | 2 |
| Reach rod | 1.25 | 1.09 | .34 | .91 | .75 | 1 |
| Rocker arms | 20.75 | 13.24 | 4.24 | 16.51 | 9.00 | 6 |
| Eng. truck equalizers | 7.70 | 17.24 | 5.24 | 2.46 | 12.00 | 2 |
| Truck frame | 15.70 | 13.04 | 4.04 | 11.66 | 9.00 | 3 |
| Trailer jaws | 2.76 | 4.38 | 1.36 | 1.40 | 3.02 | 1 |
| Extension piston cross head | 6.30 | 4.36 | 1.36 | 4.94 | 3.00 | 1 |
| Brake beams | 1.69 | 2.18 | .68 | 1.01 | 1.50 | 1 |
| Brake hangers | 5.10 | 7.45 | 3.40 | 1.70 | 4.05 | 3 |
| Smoke arch brace | 3.50 | 6.25 | 2.14 | 1.36 | 4.11 | 1 |
| Air pump valves | 2.50 | 1.33 | .53 | 1.97 | .80 | 1 |
| Lugs on valve yoke | 32.45 | 21.80 | 6.80 | 25.65 | 15.00 | 6 |
| Push car wheels | 6.00 | 10.56 | 3.05 | 2.94 | 7.50 | 4 |
| Stilson wrench | 1.60 | 1.09 | .34 | 1.26 | .75 | 1 |
| Drill chuck | 15.00 | 2.18 | .68 | 14.32 | 1.50 | 1 |
| Driver brake fulcrum | 5.52 | 8.72 | 2.72 | 2.80 | 6.00 | 1 |
| Wheel spokes | 1,276.80 | 113.08 | 35.08 | 1,241.72 | 78.00 | 15 |
| Main rod blocks | 15.88 | 28.34 | 6.84 | 7.04 | 19.50 | 9 |
| Triple valve gauge | 20.00 | 3.27 | 1.02 | 18.98 | 2.25 | 1 |
| Link blocks | 72.24 | 51.49 | 15.49 | 56.75 | 36.00 | 20 |
| Lift shafts | 23.98 | 4.02 | 1.02 | 22.96 | 3.00 | 1 |
| Quadrant | 7.43 | 11.09 | 3.59 | 3.84 | 7.50 | 3 |
| Wedges | 55.04 | 69.69 | 21.69 | 33.35 | 48.00 | 25 |
| Chafing castings | 8.30 | 10.70 | 3.20 | 5.10 | 7.50 | 1 |
| Plugging and building up holes | 349.69 | 280.94 | 140.47 | 209.22 | 140.47 | 70 |
| Tire rim keys | 3.22 | 5.38 | 2.38 | .84 | 3.00 | 2 |
| Throttle stem | 1.50 | 1.09 | .34 | 1.16 | .75 | 1 |
| Reverse lever support | 3.38 | 4.36 | 1.36 | 2.02 | 3.00 | 2 |
| Smoke box | 61.38 | 32.43 | 9.93 | 51.45 | 22.50 | 2 |
| Hub liners | 12.51 | 13.11 | 4.11 | 8.40 | 9.00 | 3 |
| Strip on crossheads | 25.32 | 31.00 | 12.66 | 12.66 | 18.34 | 3 |
| Fire door handle | 1.75 | 1.09 | .34 | 1.41 | .75 | 1 |
| Boiler casings | 63.21 | 30.30 | 9.32 | 53.89 | 20.92 | 1 |
| Frame buckle | 4.90 | 2.41 | .91 | 3.99 | 1.50 | 1 |
| Trailer yokes | 5.25 | 6.45 | 1.95 | 3.30 | 4.50 | 1 |
| Motion frame | 9.10 | 10.17 | 4.17 | 4.93 | 6.00 | 1 |
| Combination lever | 1.03 | 1.75 | .55 | .48 | 1.20 | 1 |
| Lugs on trailer hub | 4.50 | 4.52 | 1.52 | 2.98 | 3.00 | 2 |
| Center castings | 76.81 | 28.56 | 9.06 | 67.75 | 19.50 | 3 |
| Spring blocks | 1.15 | 1.09 | .34 | .81 | .75 | 1 |
| Guide blocks | 5.52 | 4.29 | 1.29 | 4.23 | 3.00 | 1 |
| Binder | 5.19 | 13.10 | 4.10 | 1.09 | 9.00 | 2 |
| Steam pipes | 3.79 | 5.12 | 2.12 | 1.67 | 3.00 | 1 |
| Flat spots on tires | 99.86 | 95.77 | 29.77 | 70.09 | 66.00 | 4 |
| Cylinder bushings | 35.65 | 9.40 | 3.40 | 32.25 | 6.00 | 1 |
| Building up side rods | 93.48 | 81.16 | 31.16 | 62.32 | 50.00 | 2 |
| Grease cups | 11.79 | 11.43 | 3.93 | 7.86 | 7.50 | 5 |
| Stationary fire door | 8.00 | 8.72 | 2.72 | 5.28 | 6.00 | 1 |
| Cracks in tanks | 372.69 | 113.62 | 35.16 | 337.53 | 78.46 | 14 |
| Petticoat pipes | 140.52 | 52.37 | 16.37 | 124.15 | 36.00 | 18 |
| Filling worn spots | 2,677.80 | 1,064.60 | 329.60 | 2,348.20 | 735.00 | 128 |
| Pins | 70.66 | 87.23 | 27.23 | 43.43 | 60.00 | 27 |
| Reverse lever parts | 103.02 | 74.04 | 23.04 | 79.98 | 51.00 | 38 |
| Total | $6,434.10 | $2,755.74 | $921.61 | $5,512.49 | $1,834.13 | |

COMPARISON OF ELECTRIC WELDING VS. OTHER METHODS

Parts That Cannot Be Welded By Gas

| Description of Parts | Cost of Other Methods | Cost of Elec. Weld | Saving | No. Engs. |
|---|---|---|---|---|
| Pedestals | $ 645.00 | $ 45.24 | $ 599.76 | 6 |
| Tank frames | 9.03 | 1.36 | 7.67 | 1 |
| Shop tools | 34.36 | 3.40 | 30.96 | 4 |
| Piston rods | 78.64 | 16.37 | 62.27 | 10 |
| Sharp flange drivers | 165.40 | 20.28 | 145.12 | 3 |
| Truck side | 194.00 | 10.20 | 183.80 | 4 |
| Building up dr. axles | 121.50 | 4.90 | 116.60 | 1 |
| Steel car underframe | 11.34 | 1.71 | 9.63 | 1 |
| Building up car axles | 315.00 | 25.24 | 289.76 | — |
| Bushing staybolt holes | 294.96 | 73.74 | 221.22 | 26 |
| Welding flues | 2,607.65 | 521.53 | 2,086.12 | 102 |
| Frames | 931.00 | 133.28 | 797.72 | 11 |
| Cracks in fire boxes | 2,431.27 | 297.17 | 2,134.10 | 92 |
| Total | $7,839.15 | $1,154.42 | $6,684.73 | |

SUMMARY

Costs and Savings—Per Month

| Cost of Other Methods | Cost of Gas Welds | Cost of Elec. Welds | Saving Over Other Methods | Saving Over Gas Weld |
|---|---|---|---|---|
| $ 6,434.10 | $2,755.74 | $ 921.61 | $ 5,512.49 | $1,834.13 |
| 7,839.15 | 3,697.42* | 1,154.42 | 6,684.73 | 2,543.00* |
| $14,373.25 | $6,453.16 | $2,075.03 | $12,197.22 | $4,377.13 |

Cost and Savings—Per Year

| | | | | |
|---|---|---|---|---|
| $ 77,209.20 | $33,068.84 | $11,059.32 | $ 66,149.88 | $22,009.56 |
| 94,069.80 | 44,369.04* | 13,853.04 | 80,216.76 | 30,516.00* |
| $171,279.00 | $77,437.88 | $24,912.36 | $146,366.64 | $52,525.56 |

*Figures show cost of gas weld if work could have been welded with gas.

Our figures show that the saving effected by the electric arc welding system is being made at the rate of approximately $200,000 a year with our present equipment. This figure includes a direct saving as compared with other methods of about $136,000. The saving arising from the fact that we keep the engines in service a greater proportion of the time makes up the balance of the figure. Our figures show that this saving is being made at the rate of about 1,400 engine days per year.

Another way of looking at the same matter is that by the operation of the electric welding system we have obtained the service of four additional engines, without the additional investment, beyond that required to install the welding system. Four additional engines are worth approximately $200,000. The

welding system installed complete cost about $40,000. The cost of operation of the system for a year is approximately $34,000. Figuring the value of the engines at $40 per day, we will pay for the operation of the whole electric welding system and will clear $22,000 from this feature of the operation of the electric welding system alone. However, we made important savings, as are shown in the preceding table, in the repair of parts on engines, where we could not show an actual gain in engine days of service, and this saving amounts to more than twice the saving arising in the increase of the number of engine days of service we get from our equipment. The net return secured on the electric welder investment amounts to approximately 500% per annum. The net cost of the installation and equipment per unit under present conditions is approximately $1,300. The foregoing figures show rather conclusively that the installation of the electric welding system has been a profitable investment on the Rock Island Lines.

In spite of the fact that we have probably a larger number of operators than any of the Western roads, we believe that we are far from fully equipped. The field of application of the process is continually widening. We are not able at the present time to handle all the operations which we have demonstrated to be practical and profitable. There is a totally unexplored field in maintenance of freight and passenger cars, which promises to eclipse in importance, maintenance of motive power. There is a field in the repair of special work, which we have not gone into up to the present time.

The present indications are very strong that when we go fully into the electric welding process in fire box, boiler, locomotive, machinery, steel tanks, car work, track work, etc., that we can well use 150 units and effect a net saving, as I have stated before, of approximately one million dollars a year. Within the last three years the arc welding process has been greatly improved and developed, both in the equipment for making the weld and in the welding material. It has, in fact, been developed to such a state that it will no doubt cause changes in many forms of construction, and the welding of fire boxes, tanks, etc., will become an economical practice. In fact, it is in the car field of construction and maintenance that we may look for a wonderful development. For instance, today the cast steel truck side frame will last almost indefinitely where the electric welder is used in maintenance. Also it is as a preventative that the electric welder has a great field by the intelligent application of spot welding with the electric arc. It will, no doubt, be possible to tie down bolts and nuts in the various parts of the rolling stock and motive power in such manner as to prevent their working loose, with the attendant very large saving in maintenance and operating expense. Quite recently we have been able, by using what is called a slag-coated electrode, to deposit steel having a carbon content of .50%, which will enable us to do some work which we have been unable to do heretofore. We can successfully take care of the worn or damaged flanges of driving wheels, and should be able to reclaim much of the special work and rail steel by successfully building up the worn parts or broken sections.

It has been our purpose in establishing the practice in the welding field to look the facts squarely in the face and apply either the gas or electric process, depending on which shows the best results at the lowest price. At the present time we are of the opinion that the electric process will supersede the gas process on all steel welding and some of the rough steel cutting. In the cutting of boiler steel and all close cutting, however, and the welding of cast iron and the non-ferrous metals, the gas process has unequaled advantage. We are operating 75 gas torches and 1 acetylene generating plant on the same general principle as obtains in the case of the electric arc welding equipment. It is also best to use gas welders at all points where only occasional welding is done and which would not justify the investment necessary for the installation of electric welder.

While we have not been able to meet the suggestion of the American Railway Association's special Committee on National Defense, which reads as follows: "About 15% of locomotives are ordinarily under repair. If this percentage were reduced to 10%, which figure has been reached by some roads, it would mean an addition of 3,325 locomotives to the number in service," we have been able to move in that direction and have nearly reached the figure of 10%, and at the same time added to the profits of the road by our welding system. It is our belief that with approximately five times the amount of electric welding capacity we have at present, we can show at least five times the annual net saving, which would amount to a million dollars a year, and that we can with this equipment in operation show a saving of around 7,000 engine days per year, which means that we would be able to secure from our present engines a mileage that will equal that which could otherwise only be secured by the purchase of 23 additional engines.

With this figure in mind, and knowing that the Rock Island Lines have approximately 1,600 locomotives in service, it is easy to realize the enormous possibilities in the direction of increasing the service from motive power equipment on the combined railway systems of the nation, both as an economic proposition and as an aid in war, were they all equipped with welders. The demand for transportation service is so urgent, and the effectiveness of the nation in this war depends so directly upon the quantity of service which may be rendered, that it seems imperative that the railroads should go into the welding field on a large scale at the earliest possible moment. These figures have been given with particular reference to motive power units. While we have no tangible data on what may be accomplished in the rolling stock field, it is our belief, from the preliminary survey of the situation, that even a greater gain can be made towards keeping the equipment in service in this field than has been made on the motive power units.

The application of the new welding processes is important now as never before, when every railroad must get the maximum of service from all of its equipment; when the nation demands the supreme effort of the transportation system of the country.

What I have just said refers particularly to railroad work and gives some idea of what we think can be accomplished, using as a basis for estimation the results we have actually accomplished on the Rock Island Lines. The enormous possibilities, however, in the application of the new welding processes to other fields are of absorbing interest in view of the present world conditions as a result of war and their effect on labor and material. Not least among the possibilities of the welding processes is that of substituting welding for riveting in bridge and building steel construction. These structures are permanent, and knowing the safety of the welded joint, from our experience with boiler work, etc., we can safely prophesy that such structures will be welded in the future in place of being riveted, from the standpoint of both economy and safety. This is a new idea, but when we consider that five years ago the complete welding of a locomotive fire box was considered an absurdity, the newness of the idea of welding steel structures is not in the least appalling.

The possibilities in the field of ship construction and repair have been explored to some extent. Every harbor on the Atlantic Coast and the large harbors on the Pacific Coast are all equipped with the apparatus. Up to the present time the welding, however, has been entirely on repair work, but the savings effected by the use of the process on boiler repairs, repair of broken stern posts, rudder shoes, propeller shaft sleeves and miscellaneous superstructure work, have been important and enormous savings have been made. It is sometimes possible to make necessary ship repairs in one day with the electric welder that otherwise would have required two weeks, and since the value of a ship at sea per day ranges anywhere from $500 to $2,000, it can readily be appreciated that there is an enormous demand for the work at the present time. The commercial

welders in the Atlantic ports charge from $10.00 to $20.00 per hour for the services of one man, which is a very good indication of the fact that the application of the process is valuable to the steamship owners. It is the understanding that at the present time the British Admiralty is welding, in place of caulking on torpedo boat destroyer hulls, which practice permits the hull to offer much greater resistance to shock of collision, shell fire, or torpedo destruction. It is reasonable to assume this practice will be extended to our navy and merchant marine in the welding of ships' hulls. Already several of the shipbuilders on the Atlantic Coast have made application for patents on the completely welded hull, and while no actual construction of this nature has been done as yet, it is probable in the near future that we shall see the completely welded hull in service.

The extensive application of the arc welding process in the United States has led other countries to the adoption of the improved practice. Notable examples of this are the introduction of welding outfits into the principal harbors of South America. In the German and English naval engagement off the Falkland Islands, the British ships were severely damaged and put into a South American port for repairs, where they commandered a marine electric welding outfit, immediately putting to sea and effecting their repairs in a comparatively short time; thus their ships were ready again for service in a much shorter time than would otherwise have been possible, when every minute was very valuable indeed. The electric welding equipments were extensively used in repair work during the construction of the Panama Canal. The South American Railway Corporation and some mining corporations are installing the portable equipment manufactured in this country. A Japanese Government expert has recently returned to Japan with complete information and the introduction of the process will probably be rapid in that enterprising country. Already a considerable amount of equipment has been shipped to Spain, Norway and Sweden for use on railways and in steel foundries.

Four portable electric arc welding units such as are in use on the Rock Island Lines are now being shipped to the French fighting front for use on military railways by the "American Engineer Regiments (Railways)." The application here covers not only the standard gauge railways which transport ammunition and supplies to the front lines, but also in the construction and maintenance of narrow gauge feeder and trench railways, the tracks of which are ordinarily constructed of small steel rails which may be welded to the steel ties, these railways being of a portable type. There are also a very large number of automobiles, motorcycles, etc., to be repaired, as they are constantly breaking down, due to the extremely strenuous service in which they are employed. In fact, without the use of the gas and electric welders, the life of such equipment would be very short indeed, when used at the battle front. Within the last year we have seen the increasing use of the English tanks, which call for very extensive repairs, that can be most efficiently made with the electric welder. The artillery also makes a heavy demand on the welders for repairing gun carriages, gun mechanism and the guns themselves. It is necessary on the front that these repairs be made expeditiously under most trying conditions—conditions that it would be practically impossible to meet were it not for the autogenous welding devices.

A little to the rear of the actual fighting front, the electric welders are in demand for repairing horse equipment, including the repairing of vehicles, and it is thought that in the near future it can be used for welding new calks on the horse shoes to replace those that are worn, without the necessity of removing the shoe from the horse's hoof. The strenuous military campaigns require frequent demolition of iron and steel structures, including heavy guns, and the electric and gas cutting processes have been found extremely valuable owing to the great speed at which iron or steel structures may be demolished beyond the hope of repair.

In many instances there is a source of electric power supply from the power lines that run in or through the theatre of war. However, in some instances where no such lines are encountered and for some reason or other it is not possible to hastily construct a power line, it becomes necessary to set up a small internal combustion power-driven unit in order to secure an electric power supply, which is becoming a necessity in modernized warfare. Electric welders can be used for trench lighting and searchlight work as well as for welding, which makes them very valuable equipment. One of the particular advantages in using the electric welder is that it eliminates the necessity for transferring welding gas, which would many times be practically impossible.

From the foregoing we may draw the conclusion that both the electric and gas welding processes are proving themselves one of our strongest allies, both at home and at the front, in fighting to victory and to world democracy the war that is now upon us.

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## WELDING.

At the last two meetings of the American Society of Refrigerating Engineers considerable time has been spent in discussing the subject of welding and especially welded containers. So far apparently most of the action in regard to the matter has been in words and not in deeds.

It is absolutely necessary that some definite step be taken. The Boiler Code of the American Society of Mechanical Engineers is an example of constructive and practical work by an engineering society. Nearly two years have been spent by the A. S. R. E. discussing welding. What is needed is a committee to take the matter definitely in hand and reach some real conclusion. As Mr. Henry Vogt said at the recent meeting, what is needed is inspection by thoroughly trained men. Get at the cause by thorough inspection and it would probably be found that accidents were not due to welding alone but to a combination of improper welding, wrong construction or design, if not solely to poor design. It is absolutely necessary to determine the cause of explosions of vessels and welded containers before any real good can be done.

Until the Society has definite and reliable statistics from competent inspectors nothing of constructive value will be accomplished.—Refrigerating World.

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## PROPOSED MERGER OF ACETYLENE AND ELECTRIC COMPANIES.

A plan has been submitted to the stockholders for the merging of the National Carbon Co., the Union Carbide Co., Linde Air Products Co. and the Prest-O-Lite Co., into a new corporation with 3,000,000 shares of no-par stock. Under the plans, the new company will be known as the Union Carbide & Carbon Corporation, and will have plants in many parts of the country. The new company will have a large number of products, including calcium carbide, acetylene gas, machinery for gas production, electric batteries and other electric appliances, acetylene blow torches and automobile equipment. Myron T. Herrick, Cleveland, will be chairman of the board of directors; George O. Knapp, now president of the Carbide Co., president; J. S. Crider, Edgar Price and M. J. Carney, vice-presidents; H. E. Hackenberg, secretary, and Giles W. Mead, treasurer and vice-president.—*Iron Age.*

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## CARBON PRODUCTS.

Carbon blocks, paste, etc., such as has been referred to in recent articles in *The Welding Engineer*, may be had from the National Carbon Co., Cleveland, Ohio.

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The Torchweld Equipment Co. have issued a circular relating to their new catalog, which will be issued at once.

# *Hints for the Welder*

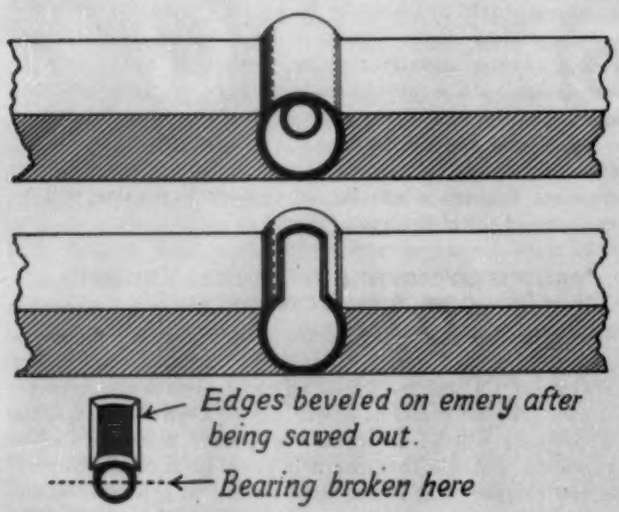
*When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way—I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today—the men on the firing line are waiting.*

*L. B. Mackenzie, Editor.*

## WELDING HARVEST MACHINERY.

Editor: The following job should be of interest to the readers of *The Welding Engineer*. Occasionally welding jobs are turned down owing to the inaccessability to the part to be welded. Just such a job came to my notice lately during Harvest. I do not know how many welders make a business of welding harvest machinery, but I do know that this line of work is practically unlimited, and that the price is of little consequence to the busy farmer.

Upon this one occasion, one of my farmer friends, of whom I have many since coming to their rescue with a




welding outfit, came to the shop with the dreadful news that he had a broken a part of his binder, and that it would be impossible to get at the broken part, and to dismantle the machine would be a greater task than to cut the grain, etc. I made a trip to the scene, and found that he was partly correct, but unnecessarily excited. I proceeded to saw out the part to be welded, which consisted of a small cast bearing, of which the lower half had been broken off. This was suspended from the top of a recess in the main frame which made the repair as it was impossible. After repairing the break over a carbon core, I beveled the edges of the part sawed out, and proceeded to weld same in position from the top, which was a small matter.

C. A. Hare.

## CULTIVATOR PARTS.

Editor: We have a number of short pipes here 1½ inch inside diameter (illustration attached). You will observe the pressure arms are attached to these pipes. There is a severe torsional strain on these pipes and we have known them to sag toward the front of the frame in practical field operation. We have been using up these short pipes by putting a piece of steel inside and putting a rivet through each way in each end of two short pipes connected together, and then covering the seam by welding. Do you think it would be sufficient to weld these pipes only, without riveting a piece of steel inside? The outside diameter of pipe is 1.900, the inside diameter is 1.494.

T. A. Co., Ltd.

Answer: Referring to your inquiry regarding welding of pipe which is used on your cultivator, we note by the illustration sent us that there is a very severe strain on this pipe as it actuates the teeth.

We doubt whether pipe of the thickness used will withstand the torsional strain and believe that a solid bar should be used.

Your inquiry relates, however, to the strength of the weld and if the weld is properly executed, it should be practically as strong as the pipe itself. If, therefore, the pipe is strong enough to withstand the strain, the weld certainly should be. But, as we have already stated, we doubt whether the pipe itself is strong enough.—Editor.

## WELDING MALLEABLE.

Editor: I have a number of malleable parts to weld. How shall I weld malleable to a round steel plate. The malleable piece is about 12 inches across and has a 4-inch flange in it. This must be welded in solid as a hub for a sprocket wheel.

A. W. D.

Answer: Clean to a brightness both steel and malleable. Heat each plate to a bright red, care being taken not to melt the surface, sprinkle the surface with a little brazing flux, heat again to a bright red, and with a ¼-inch tobin bronze rod, plate the edge and surrounding surface with brass. After both plates are surfaced with brass, set them in the proper position, and heat the edges to be joined until the brass will melt in the plate and then add from a tobin bronze rod sufficient metal to penetrate through the joint. Then allow the plates to cool slightly. The same operation may be performed in the joining of steel and cast iron, pro-

viding the proper cleaning flux is obtained, in which case use a cast iron rod for a filler, together with cast iron flux. —Editor.

## FOOLING WITH THE BUZZ SAW.

Editor: I was talking to a welder the other day, who has been *welding* about five years, and he gave me some *information* that put me to thinking and wondering if there were not others like him.

He had been using compressed acetylene, until recently he had gotten in a 25-lb. generator of the diaphragm feed valve type, a very substantial looking machine, and I was asking him how he liked it. etc. He said it was not working very good; he couldn't get enough pressure on it. I asked him how much pressure he was using, only 30 pounds he said. I kind of backed off a little at that, but continuing the conversation, he said he was going to get a stronger reducing valve and put on it so he could generate up to 75 or 80 pounds. He thought it would make a better welding heat.

Well, I did not know hardly what to say to that as it looked to me like a hopless case, but finally I ventured the suggestion that I thought he was taking a very hazardous risk by generating 30 pounds. Oh, (he said) it is perfectly safe with 150 pounds of pressure—had been tested to that. I told him it might possibly stand 150 pounds of cold water pressure but not *acetylene gas pressure*, and if he valued his or anyone else's life, not to try to pull off a "stunt" like that with acetylene gas. I don't know if he has tried his *strong* reducing valve or not. I have not yet heard of anything happening over there.

Now I can't see for my life, what he wants with even 30 pounds of acetylene pressure to weld with and somebody has told him he is a good welder and he believes it.

I know I don't know very much about it, and thought perhaps some experienced welder might teach me something along this line by commenting on this article through the Welding Engineer's columns.

W. A. Bennett.

## WELDING A GEAR WHEEL.

Editor: I am contemplating welding a cast iron gear wheel, 4 ft. in diameter and 3½ in. face, which is used for pumping a deep well. It has a heavy counter balance cast in between two spokes, to offset weight of plunger. Please inform me as to pre-heating and proper cutting away preparatory to welding. What would be the proper position to place wheel in for welding? Will counter balance interfere in pre-heating enough to cause irregular expansion and contraction? Which would be best way of heating wheel, place it in an oil furnace, with counter balance directly under, or a wood fire in the ground.

H. L. Blackwood.

Answer: The break you mention in the wheel can be welded by chipping the broken edges to a 55 degree angle from the inside of wheel, leaving about ⅛ stock not chipped, so you can replace the broken pieces on its place as per figure 1. Then place the wheel on leveled brick platform. The proper way to get it level is to smear the surface of bricks with the broken pieces on top of it. Then get carbon blocks shaped as per figure 1, as many as necessary and have them prepared before welding. Build a furnace and provide for draft by separating the bottom row of holes about one inch apart, have the furnace about 2 in. higher than the wheel. Then fill the furnace with charcoal and coke mixed, and kindle same through the draft holes with a gas blowpipe. Try and get the rim cherry red and when this temperature is attained, place one carbon at a time, and weld the fractures from the inside of the rim. The piece cut out in the carbon will reinforce the welding line. After welding is finished, close all the holes or crevices with fire clay, and then cover the top with asbestos tight, and leave it to cool for 48 hours. Then you will give the owner a practically new wheel, and there will be no machining to it. Of course, the wheel must not be moved from its fire clay foundation from the time it is set until after it is entirely cool. To save your time I am sending you the sketch above referred to.—Editor.

## THE DUTY OF THE AMERICAN WELDERS IN THESE DAYS OF WAR.

Editor:

In his proclamation of April 16th, President Wilson said: "To the men who run the railroad and mechanical industries of the country, whether they be managers or operative employes, let me say that the railroads and metal industries are the arteries of the Nation's life, and that upon them rests the immense responsibility of seeing to it that these arteries suffer no obstruction of any kind, no inefficiency or slackened power."

To this appeal the railroads and metal industries are responding splendidly, doing all they can to utilize every available energy, and to decrease waste to the minimum.

There must be a saving of energy, not only on the part of the railroads and large steel industries, but also on the part of our foundries and smaller private concerns or other public utilities. This is the real time when the oxy-acetylene operators can do their share by reducing the Nation's scrap pile.

Throughout the land there is today more work to be done than there are welders to do it. Nor is the situation going to improve as the war develops. More and more men will be needed at the front and as the men go into battle line the greater the burden and the duty of those remaining behind. This applies more in particular to the American welders left at home.

The next question is have we sufficient welders, or are the present welders prepared for such an emergncy? The writer's opinion is that we are lacking 75 per cent of welders and that the majority of the 25 per cent are not adapted to the particular requirements of the task. Then, what have we done to respond equally to our President's call for efficiency?

We have organized a welder's association with the purpose of producing more and a better type of welders. But the American Acetylene Association formed of over one hundred conscientious and practical welders are not sufficiently strong to properly and promptly develop without the co-operation of manufacturers and employers of welders, as well as the welders themselves, we will not be able to raise the welders' banner to the same height as other industries.

This organization is not and must not be construed as a union and is not organized for the purpose of uniting men with this view in mind.

The association's aim is to produce more efficient welders, and is fighting a war against waste, ignorance, and untrained abilities.

At all our meetings we have open discussions on the various methods of welding different metals, also take up complicated questions which confront its members, while at their daily work. Taking it all in all, the association's purpose is very similar to that of the S. A. E., and if one should refer to the issue of the trade paper *Automobile Topics* of May 12th, page 21, and of *The Welding Engineer* of June, page 28, he can find a short vivid write-up in reference to the Welders' Association.

This association has undertaken to instruct and examine welders by a board of five reliable and competent men, so as to help

increase the number of master welders in this country. Our various committees are also giving free advice to the manufacturers, government officials, and to the welders themselves.

Therefore, we need the co-operation of all men interested in the welding industry to enlist in our ranks, and by doing so we will all realize what wonderful opportunities this association will offer its members, its industry, and the country at war.

Men interested in the welding industry should write today to the secretary of the American Acetylene Association, Y. M. C. A. Building, Jackson, Mich., for an application blank and by-laws.

B. Kopferschmidt,
Jackson, Mich.

## BIG WELDING JOB.

The severe shock and strains which heavy steam hammers are constantly subject to, often result in cracked or broken cylinders, anvils, and hammer columns.

Defective castings, blowholes, shrinkage strains and faulty cores are also responsible for many of the breaks which are successfully repaired by welding.

The above photograph shows two broken steam hammer columns recently welded by the Torchweld Equipment Co. in their welding shop, located at Fulton and Carpenter streets,

Large Welding Job at Torchweld Shops.

Chicago. As the columns weigh approximately 16,000 pounds the handling of so large pieces requires heavy lifting facilities. The large travelling crane located over the fifteen-foot welding bed is amply able to carry both columns if necessary, and saves, of course, considerable time and hard work when lifting and turning of the large pieces is required.

The columns were bricked in around the breaks and preheated with charcoal, and the welding done by the oxy-acetylene process.

## AN IMPROVED METHOD OF WELDING OVERHEAD WITH ELECTRIC ARC PROCESS.

By Robert E. Kinkead.

A great deal of time has been spent by operators of the electric arc welding process learning to weld overhead. Some men never learn it, others have rather poor success even after long hours of practice.

The method described below is one which may be used in welding of cracks and seams in crown sheets or on any seam in a vertical plane. Any operator with a few weeks' experience with the process can do the work and the results will be uniformly satisfactory.

Welding overhead requires more current than welding in horizontal plane. Any welding machine should be set to

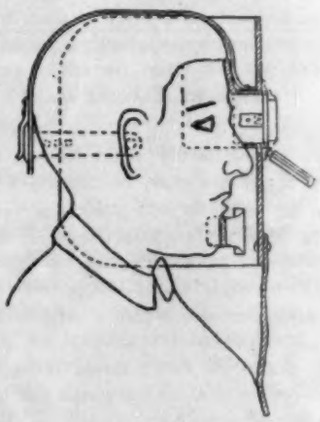


Fig. 1

give its maximum voltage for overhead welding, because the tendency for the arc to "hang on" is greatest when the voltage is highest. The most difficult part of the welding should be done with ⅛-inch electrode, using from 130 to 150 amperes. In working overhead with a rather heavy current the metal deposited may stay red hot for a few seconds. The operator should always wait until the last layer of the metal deposited has cooled to the point where no color can be observed to avoid having the metal "run" badly. The work should be brushed thoroughly with a stiff wire brush between each layer.

The operator must have a shield which is comfortable and which allows him to see a weld without straining his

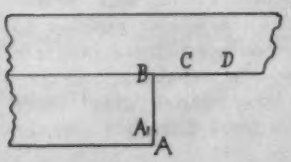



Fig 2

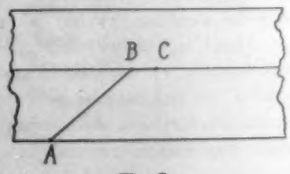



Fig. 3

neck. Both hands must be free. One hand should be used to steady the other. The shield shown in Fig. 1 is one of the latest and probably the most satisfactory one obtainable at the present time.

Fig. 2 shows the easiest case of overhead welding. The weld should be started at the bottom and carried diagonally upward (see Fig. 3, side view). This may be carried the length of the seam, laying one head of metal on and always following the pattern. The next layer can be started in the same manner at A. and carried to D. The important

thing is to keep the diagonal pattern which makes the work easy to do.

Fig. 4 shows a typical overhead crack which has been properly V'd out. Welding the crack in this condition is very difficult and in most cases results in an unsatisfactory job. The job can be made easy by following this method: Cut a piece of ⅛-inch sheet about T ("T" equals thickness of plate) inches wide and of a length from 3 to 6 inches, depending on the length of the crack. If the chack is long enough cut enough 6-inch pieces to go the length of the crack. Now stick a ⅛ or 5/32-inch electrode near the center of one of these pieces and very close to one

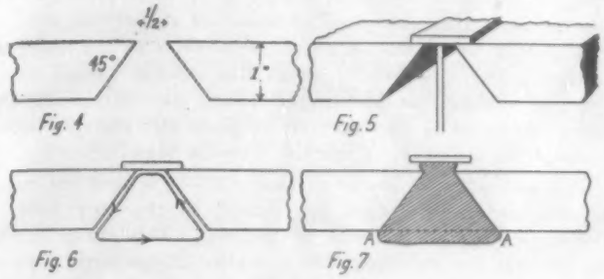


Fig. 4


Fig. 5


Fig. 6



Fig. 7

end. This provides a handle. Poke the piece up through the crack and bring into position, shown in Fig. 5. Tack the ⅛-inch piece in two or more places, and weld according to the pattern shown in Fig. 6. Allow metal to cool between each layer so that the color disappears. Brush between each layer. In actual boiler work it will usually be found that the ⅛-inch piece will not fit down tight over the crack due to the boiler scale. This will actually help the job rather than hinder it so long as the gap is not more than 5/32 inch. The section through the weld will look like Fig. 7. The excess metal beyond line A-A may be chipped off so that the weld is flush with the plate.

The same plan may be followed on seams in a vertical plane. The great advantages of the practice are that any operator can do the work and that it puts the reinforcing on the water side of the plate.

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## REPAIRING CRANK CASE BY WELDING.

When a crankshaft becomes bent from an accident of this kind, it usually cracks or otherwise mutilates the crank case or engine face, or both. Many of these can be repaired by an expert oxyacetylene welder, but it is very necessary to hold the pieces firmly in position to prevent their being badly warped by the local application of intense heat. To avoid this, heavy cast-iron blocks are to be used, to which the cases will be bolted so as to hold them firmly in position during the welding operation. In this connection it is interesting to note that a large heating furnace has been provided into which the crank case, already bolted on its heavy cast-iron form, can be heated as hot as may be necessary, before the welding is attempted. This, in some instances, is about 200° below Fahrenheit, the melting point of the alloy, as this temperature has been found to assist the welding to a large degree and also to prevent warping after the piece is removed from the cast-iron form.

There is also considerable repair work on the engine radiators, which means sheet-metal work, soldering and brazing to a considerable extent. In all the repair departments it is necessary to exercise extreme care, particularly when green men are being broken in.—Extract from article in "American Machinist," entitled "Airplane Engine Repairs at Toronto."

## ARC WELDING IN STEEL FOUNDRIES.

By D. B. Truitt.

Of all the different articles I have read relating to electric welding none have been written with the view to assist the carbon-arc welder employed in steel foundries. It is a general belief that no skill is required to weld in such places, and that anyone can do it. Such a belief is a mistake, as it requires more skill than most people think. Ninety-five per cent of the mistakes that are made in the foundry must be corrected by the welder. If the metal in entering the mould washes away part of the mould the welder must repair it. Some seem to think that a welder has only sand holes and shrinkage holes to fill up, but they are mistaken. What becomes of the castings that are poured when the metal is cold and will not run properly? Do they scrap them? No! the welder must add metal with his arc and filler rods to make the casting the proper shape. When a moulder forgets to put part of a pattern on when making a mould, and the finished casting is minus this part, the welder must add metal to the casting the same shape as the piece left off by the moulder. When the dry-floor moulder puts the wrong core in, the welder must correct this. The welder is misnamed, he should be called an electric moulder, instead of an electric welder. Yet the welder is looked upon as a necessary evil, he is installed in some dark and ill-ventilated part of the shop and he will be out of the way. Let me tell you his surroundings are far from being ideal. I have read several articles referring to the carbon-arc system of welding which claim that no skill is required, and that anyone can learn in a few hours. The above statement is being made by a certain manufacturer of carbon-arc and metallic arc welding machines. I once employed a welder who claimed he had been employed by the same firm that I have in mind. He claimed he was a demonstrator for them for two years, and that he had been welding for 12 years. Now this man was far from being a first class welder and I had to let him go on account of his poor welding. Now any one claiming that a man can learn in one or two days is making a false statement. Now up to the present time I have not found a man who could master the carbon-arc to my satisfaction in two weeks. As a general rule it takes from three to six months to produce a first class welder. Now with the metallic arc it is different because it is just a matter of holding the metal electrode the proper distance from the work and moving along at the proper speed. Put the carbon-arc in the hands of an experienced man and the chances are he will burn the metal and have his weld full of slag. Now slag in a weld is very bad as we all know it decreases the tensile strength and ductility besides leaving ugly black lines and spots when the weld is machined. It is a well known fact that slag is lighter in weight than metal and if the two are melted together, the slag will float on the top, just as oil will float on water. Now with the proper manipulation of the arc, all the slag can be brought to the surface of the weld and by holding your electrode holder on an angle, all the slag can be flowed from the weld. Thinking to gain time in instructing new carbon-arc welders, I employed some very good oxy-acetylene welders, but I could not instruct them into carbon-arc work as readily as I could a green man, because they could not break themselves of the habit of handling the electrode holder as though it was a gas torch. There is so much difference in the two systems. I held a conversation with a self-styled welding engineer the other day and he said that carbon-arc welding as is done in steel foundries at its best was only patching or doctoring. Supposing this to be true—do not put all the blame on the welder, nor on the system, but place it where it rightfully belongs. That is to the foreman in charge of

the work (who is no doubt a man who knows nothing about welding). He comes to the welder with a casting and will say "This is an express job, don't bother to burn it out, just *smear* it over, you don't have to be too particular, because the team is waiting." Isn't that a familiar expression boys? Here is another, when the work is coming bad, and your pile is getting larger, he will say, "Go ahead and hog it wherever you can, or we will never get caught up again." If anyone doubts the above expressions let him get a position in a steel foundry and he will hear them, and lots more along the same lines. So you see we cannot place all the blame on the welder, when he is told not to be too particular. Yet the welder must bear the brunt when the customer makes a howl about defective welding in his castings. Then the customer decides that welding is patching and doctoring.

One of the things that gives welders in this class of work considerable trouble is checks in castings due to what is known as red shortness, that is checking while the casting is red hot. These can be welded in a satisfactory manner and with little or no preparation. First see that your positive line is free so it can be moved to any part of the casting. This is absolutely necessary in some cases, because the arc has a foolish

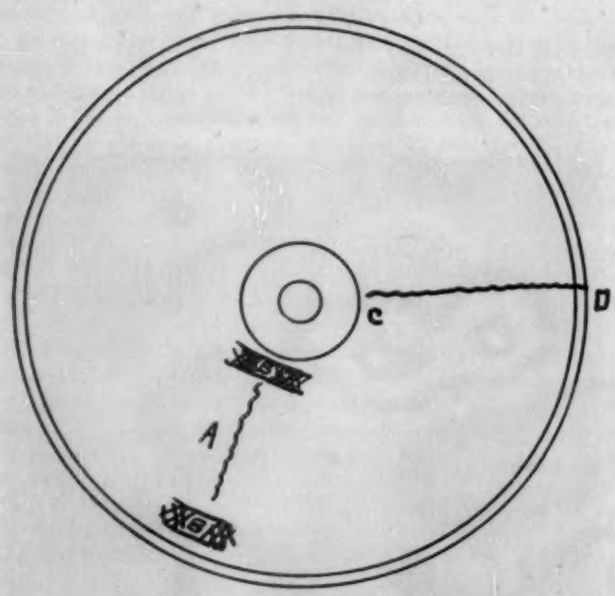


Fig 1

habit sometimes of going anywhere but where you want it, so if your positive line is free to move about you can get it in some place where you are able to control your arc. Why it does this I do not know. I have asked several what was the cause of the arc acting so foolish by going in any direction but the one you wanted it in. Some said they never heard of it, and others started to explain, and between you and I, before they were through I could not tell you if they were talking to me in Greek or Latin. One thing that was made clear to me was that the arc always travels to the point of least resistance, so I sum it up this way, that the point where we want the arc offers more resistance than the place where the arc persists in going. This I also know that by moving the positive line to another part of the casting invariably gives you the desired results.

Now lets get back to those checks again.

Nearly every welder knows that if he gets a wheel with a broken spoke he must heat it on the rim on either side of the broken spoke and that if he gets a wheel with the rim broken he must heat the hub. But all of them do not know how to treat all checks, and there are lots that give him considerable trouble.

Some believe in equal expansion, and place casting in a furnace until it is cherry red all over, and weld it while at that heat. Phew! some hot, eh? In the days of water barrel resistance a certain builder of locomotives would not accept an electric weld no matter how small unless the casting was preheated to a cherry red, then welded. Well I welded driving wheels for about one month for them in that way (I have another job now). Funny how I drift away from those checks isnt' it? Below I am giving a sketch of two of the most frequent checks in a steel foundry. Of course there are castings of all sizes and shapes, but there is really only two kinds of checks regardless of the shape of casting. There is first the check that does not reach either edge of casting, but is confined in any part of casting, the other is the check that starts at no particular place and runs through to the edge. I refer you to the sketch.

We will take the sketch marked "A"—it is thru the metal to the bottom but does not extend to the core hole in the center nor to the edge of the rim. This check should be cut out for full length and depth. Now drive a small wedge into the center of the check and then play your arc on casting as parts marked B.B., first on one and then on the other, and in a few minutes you will be able to remove the wedge with your fingers because the action of the heat at both ends of the check expands the casting in such a way that it opens the check. Now make a rapid weld and do not stop welding until weld is complete. If the check is too long, or the metal too thick, you can get the same results by welding say 2 inches on first one end of the check and then the other until the weld is complete.

In a weld like the one shown at C & D I have seen so many welders start to weld at point D and work toward point C, and they wondered why it would open again on cooling. For an experiment, take a small wedge made by hammering flat one end of a nail, drive it into the check at point D as tight as possible, then commence welding at point C and before you have welded half way between the two joints your wedge will have dropped out, due to the casting expanding in such a way as to open the check at point D. Just bear in mind that in contraction you have the opposite in expansion and if you see the check is opening up ahead of your arc, you know then that it will hold when it is cool.

I think it a good idea to have a small wedge in a check that you are welding and try it from time to time. If it is loose, continue your welding, but if it is getting tighter stop welding as it is only a waste of time, for the weld will break open when it has cooled. Of course, there are a great many different methods, but I find the above one of the most simple methods that I know, and have used it for years myself. There is not a branch of the welding service that I have not had practical experience in. My reason for taking the carbon-arc for an article was because I wanted to remind the boys in the other branches of the industry that the welder in the steel foundry has to have intelligence and use considerable skill in some jobs, that he must not be looked down upon. The conditions he works under are not always ideal. To protect ourselves we must pull together and break yourself of the habit of knocking the other fellow or his system. If you are a gas welder, do not condemn the metallic arc welder because he cannot get results on brass, just remember he has you beat on steel. And so on we must now work together for our future benefit. Every system is the best on certain classes of work. What I mean is that one system is suited to certain classes of work better than another.

All of us know that the oxy-acetylene has a greater scope

than any other system but that is no reason why those employed in that branch should knock any other branch. It is up to all of us to convince the public that welding is past the experimental stage and that it can be relied upon. To me welding is one of the greatest wonders of the age. Put the tools into the hands of an experienced man and he will make most anything you desire in metal.

Now get together and boost each other along. It is not up to one, it is up to all of us to convince these (engineers) that welding is good and can be relied upon; show them that they are mistaken when they say it is not good for this or it is not good for that. If you find a welder who is not up to the standard help him out and if he is doing any tension work watch him closely, because if it fails he is not only doing himself an injury, but it is also an injury to the entire industry. Let's try to eliminate these occasional failures and be able to say this job is perfect. In that way we can make the engineers forget about the thermal disturbance in the vicinity of the weld.

## SOME NUTS I WOULD LIKE TO HAVE CRACKED.

By A. Cetta Leine.

One Tuesday afternoon I was sitting in the office smoking a long black cigar with a gold colored and embossed band on it (they were really two for a nickel cigars, but I like to smoke them when in the office as it makes one look prosperous), when the Sales Manager handed me a copy of some letters he had been dictating, the letters saying, in substance, that they were sending their Welding Engineer (pardon the assumption) on a special demonstration trip into their territory and that they were welcome to put their welding problems up to me for solution. These letters had Monday's date on them, and probably had gone out on Monday evening's mail, so I had a hunch that yours truly would be headed for the sticks in a few hours. To confirm my hunch I peeked over the stenographer's shoulder, and saw that the dear girl was already writing a list of the towns and customers included in my list.

Just then the Manager came up and said, "I want you to leave tonight for the starting point of your route, and I want you to cover your list very thoroughly, and see if you can't increase our business in that territory; in fact, young man, I am expecting big things of you."

With that he shook my hand and said, "Beat it."

I hurried home and told friend wife what the boss had said, and like all good wives she said she was proud of me, and was sure the boss had an interest in me. Well, I put a couple of boiled shirts, some collars, a clean overall suit, and a welding torch in my grip, and kissing Mrs. Leine and the kids good-bye, I raced out toward the street car line. I always ride on the street cars because its cheaper than a taxi, and does not look so exclusive. Now, I am no colt, so you will wonder why I raced out. It was to get away before the wife and kids started their usual tear activities (they really hated to see me go, and I mention the children so you will know I am no "Slacker").

My first stop was a town of some 60,000 souls and six or seven welding plants. I'll admit that some of them could really weld, and they were all experts as far as I could learn.

However, I noticed that they took good care not to weld any while I was in the shop. I guess they were afraid that I would steal their trade. I really was disappointed, as I need the occasional exercise of demonstrating to keep me in "form."

That evening I left for a little city of some 5,000 inhabitanst, located in the center of a very rich oil field. The next morning I started out to find if there were any "expert" welders in that city, determined to leave no stone unturned in my search. The very first place I lit nearly finished me. It seems as though the owner of the welding shop was a self-made man and very proud of the maker. I handed him my card and after the formalities were over he told me what he thought of my company, and some of their Welding Service men, mentioning no names of course.

One incident he told me of happened at Okmulgee, where he said a demonstrator, or Service Man, could not weld a circular patch in the side of a boiler. The self-made man said the Service Man told the boiler shop foreman (the place was a boiler shop) that it was an impossibility to weld it. Maybe he did and maybe he didn't. Most welders are shameless liars, as the rest of my story will bear out. I asked him the man's name and the date it all happened (you see I was in that city once and called on the very same shop he mentioned, but he did not know the man's name and the date was long before I was ever in that beautiful city).

Anyway I didn't get to see any boilers on my visit to this certain boiler shop as they said they were getting along fine. A white lie maybe, so I know he didn't mean me.

Gentle reader, can you imagine your humble servant, who has spent the best years of his life swallowing heat, grease and nasty odors having to listen to such stuff as this, helpless except to say "How Funny," that's a joke, or somebody and other such polite remarks.

This fellow also had a mouth that had a reach of an octave or more, and I never did like wide mouths. Their owners usually are overbearing and conceited and are only waiting patiently to advise the Creator on how the world really should be operated.

I wanted to run my fist down his throat, an inch or two, but the great Creator of white men and welders didn't make me very heavy in my shoes, and I had on a palm beach suit, and I did not want to get it mussed.

So, my friend, if you want to stand high in the writer's opinion and have a mouth that extends from ear to ear, take a few stitches on each end.

The next place I called on was a boiler repair shop. The owners of the shop said his welder was also an expert, but had sense enough to take advantage of an opportunity to learn something.

The welder had gone over to the grocery in his "hoopy" to buy a cigar (nobody of class walks in this neck of the woods) and the owner of the shop told me confidentially that the welder was having trouble welding cracks in boilers, and if I could show him how to overcome them he would appreciate it. I was pleased to shake hands with a bright young man who had entered our noble profession two or three years ago. He readily admitted that he was having trouble welding cracks and other defects in boilers, saying he supposed he didn't get the expansion right. The truth of the matter was—well, let's go on a bit further and see. They fished out a boiler and we got ready to work on it. The defect was a crack in the fire door ring. Anyway that's what I would call it. After he had cut through the crack with a torch and chiseled the oxide off under my direction (no real demonstrator will do any of the dirty work himself), I started welding the crack and when I was half way across, he said, "Say, Mister, let me try it that way." I handed him the torch and he finished it, welding it in the manner that I started doing and made a neat job of it. Did it crack? I should say not. It didn't even grunt when cooling off. The trouble was, he was not welding before, he was only plastering. Welders of the type he had been should join the plasterers' union. The owner of the shop was so pleased that he took me around in his car to

(Continued On Page 36)

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## Welders Who Study.

A GREAT many men who have not had the advantage of a technical school education or even of an apprenticeship, are ambitious to secure better positions by self-education. *The Welding Engineer* is constantly helping and advising many such men. We would advise every welder, who seeks to become a credit to the craft, to study and read everything obtainable on the subject of welding. The literature of the trade is being constantly enriched and it's a smart man indeed who is unable to profit by it. To those who encounter obstacles and difficulties we offer such advice and assistance as we are able to give.

## What's It Worth.

A WELL known manufacturer of welding equipment recently established a school for welders, fixed prices being named for courses of instruction of varying lengths. It seems to be the opinion of many that the prices named for the instruction are too high. This is probably due to the mistaken idea that a manufacturer should give something for nothing.

Teaching the novice the details of the art of welding is an expensive undertaking. Every mechanic is necessarily obliged to serve an apprenticeship and it is unreasonable to expect an instructor to turn out a competent welder, even though he possesses the basic foundation of a good mechanical training, in a few days. The trade of the welder is worth while. There is a constantly growing demand for his services at good pay. What should a man be willing to pay for a first class education in a trade he is going to make his life's work? He certainly can't expect to receive it as a bonus with the purchase of a can of flux.

## The Stimulus of War

THIS is a war of machines, transportation, supplies and money. Because of this, men's minds are being stimulated. Their vision is being broadened, and they are becoming more ambitious. The world is learning a great deal more about what can be done with materials, how production can be increased, and how costs can be reduced. In a recent issue of *The Saturday Evening Post*, an author, who is supposed to have been at one time in service on a German U-Boat, tells how a submarine net in which his boat was enmeshed was cut in a few moments with an oxy-acetylene torch. Cutting under water is not in itself new, but that the process should be used under such unusual conditions is very remarkable, and serves to illustrate the rapid industrial progress we are making.

## The Value of a Trade Mark.

DOES the average person ever stop to think what a safe and easy thing buying has become in our day? What a contrast to the way it used to be within the memory of most of us: Today it is safe for the housewife to send her little child to the corner grocery. She sends her with perfect confidence that, even though a child, she cannot err therein. In the case of all staple produce the price is known, the quality is known, and the **name** is known. Such is the power of a well-known trade name, a name which has been built up on good goods and fair dealing. In former days buying was just a game of "let the buyer beware." The greatest achievement of Modern Advertising is that for the first time in the history of the World's merchandising it protects the buyer. The value of every trade-mark depends on the good will of the buyer, so back your trade name up with value, and then advertise the trade name.

## Protecting the Eyes.

MANY welders are inclined to hold the proper protection of the eyes while welding too lightly. Too much care cannot be given this subject. The instantaneous effect of working without goggles, with the oxy-acetylene flame, may be slight, but nevertheless there is a very damaging effect, which may be very apparent to the welder in later years. A prominent arc-welding engineer, who was recently asked if the arc-welding process was hard on the eyes said, "There is less danger of the operator injuring his eyes, using the electric process, than by using the oxy-acetylene process. The reason is that while using the electric process, it is impossible for the operator to work without proper shields, whereas with the gas process he can work without a shield, and it is at this time that the damage occurs."

This engineer has apparently observed the carelessness and indifference of some operators to personal injury. Foremen and shop owners, for the good of the industry if for no other reason, should insist upon their operators protecting their eyes while at work.

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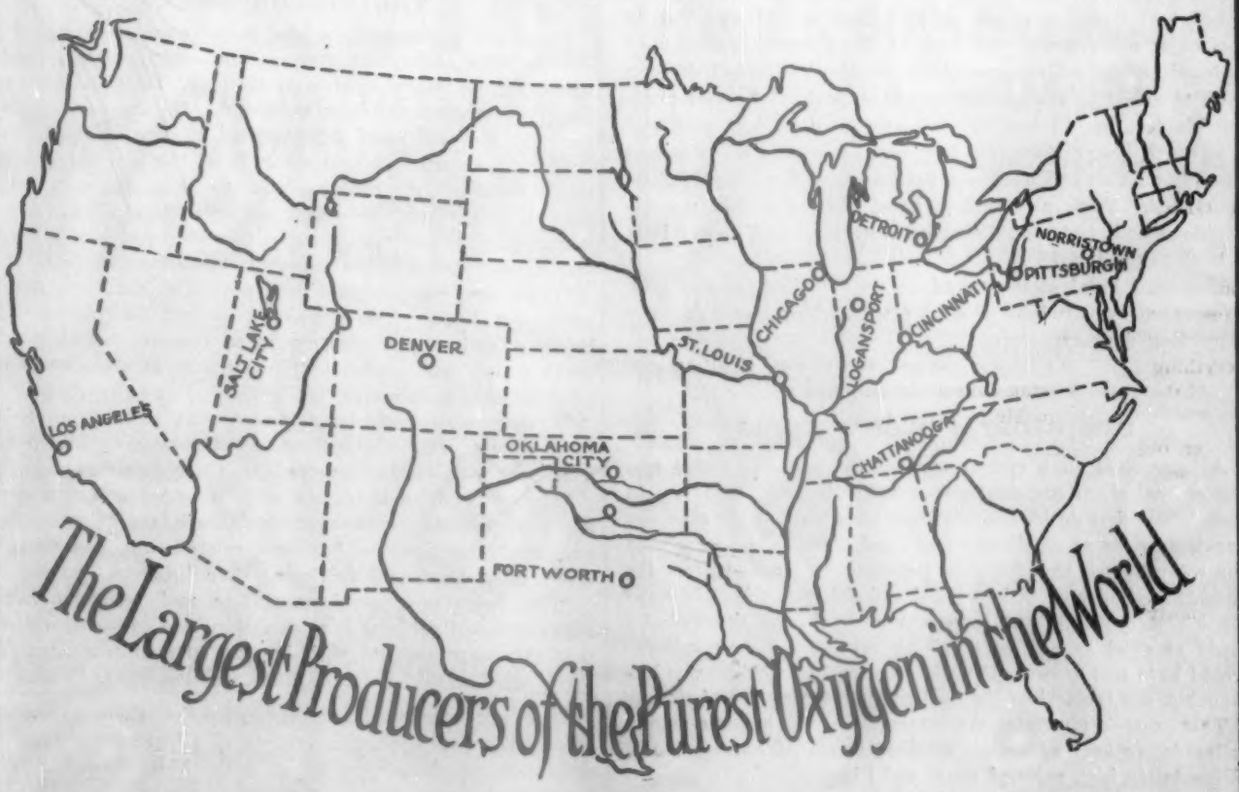


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## SOME NUTS TO CRACK.

(Continued from Page 33)

see the rest of my customers. When I left him I told him confidentially that his welder would not be bothered with cracking any more.

The trouble that most welders have, and which they attribute to a variety of causes, is, my dear friends, due to the fact that it is not welded, just plastered or smeared on.

The rest of my stay in that city was uneventful, save that I got to see some jobs that my self-made friend fell down on, and which any slug should have gotten away with. The next town I visited had a large job shop in it doing a great business welding oil well machinery and tools such as boiler buckets, etc.

I watched him weld a few minutes, and then I asked him if his work always held. He extended his chest some three feet, and as cordially as the Belgians welcomed the German invasion, he said, "Yes, sir, they always hold." (I hope so.) To have offered to show him the first steps in welding, would have been committing "lese majeste." I do not like to commit such a serious offense. I am too patriotic.

However, I felt thankful that the American Acetylene Welders Association at last had been started and that maybe some day they would place such welders as he in their right class.

The rest of my customers in that city were simple, kindly creatures, and let me show them a few things. Some day they may be a credit to their profession.

The next day I made a jump of some forty miles south of the aforesaid town. I want to tell this and then I'll quit.

There was an old boy who run a Job Shop (Job welding) and was doing a good business. By the way he used clear glass in his goggles, a bright idea for an old slug like him. Of course, being so much older than myself he would not let me show him any new stunts, but when he found that I could take orders for supplies he gave me a nice order. I noticed that he did not order any cast iron filler rod and I asked him how his supply of this kind of rod was and he looked at me proudly and said, "I don't use cast iron filler rod any more on my cast iron welding." "What do you use?" I asked in amazement, thinking perhaps he was brazing his casting. "I use Norway iron on them," he said, and it is much better than cast iron rods, it makes a softer and smoother weld, and does not have any hard spots in it," he concluded. With a nerveless hand I handed him my indelible pencil, and said, "Sign here, please," and then I beat it back to the hotel.

The kind hotel clerk looked up as I rushed in, and said, "Young man, you look sick." I was. Moral—Don't envy a welding demonstrator.

F. E. Totten.

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## THE IMPORTANCE OF WELDING

A locomotive on a central western railroad was towed into the general shops one day with a badly damaged cylinder. In fact, it was first decided by the shop foreman that the case was hopeless as far as repair was concerned. The road was pressed for rolling stock and the shop superintendent decided that the damaged cylinder could be welded and the engine kept in service. The oxy-acetylene process was used and the cylinder made as good as new at a trifling expense. A new cylinder would have cost around $750, while the cost of welding was less than $20, not taking into the final account, the saving of time.

This example illustrates the conservation now in force among railroads, as well as among machine plants of various kinds, owing to the high price of metal and labor.

A paper company was sadly in need of metal cores, on which the big rolls of paper are wound. Tube mills were far behind in their orders, and there was a slim chance of getting any action in that direction. Some one thought of the junk heap, where broken and defective cores were piled. Out of a three years' accumulation the company was able to reclaim several car loads of the tubes through the simple process of cutting and oxy-acetylene welding short lengths into desired lengths.

One western railway was preparing to tie-up several hundred locomotives because of the shortage in supply of renewal boiler tubes. Digging into a five years' accumulation of junked boiler tubes, the company was enabled to salvage and repair, through oxy-acetylene welding, more than enough tubes to put all the "dead" engines in commission, when rolling stock was so badly needed, and at an expense that made it worth while.

High speed steel is growing so scarce, owing to the enormous demand for it, that many concerns are meeting their urgent needs by oxy-acetylene welding short ends of this material into pieces large enough to be used again in tool making.

Small tools in most plants rapidly run into money and considerable losses are experienced, even in normal times, if breakage is not taken care of. Therefore modern welding processes are coming into daily use in all of the larger shops and many of the small ones, merely to cut down this waste that saps the profits of the year's business.

Efficiency engineers have long contended that the best way to save tools, machines and materials is to reclaim them and use them over again, if it can be done at a profit. Of course, if shops were still dependent on the old forge idea for welding, this salvaging would be out of the question, but modern engineering has shown the way out and is rapidly promoting the use of the electric and oxy-acetylene welding process.

In one plant, stub ends of nickel anodes, used in electroplating, were sold as scrap at a low price to get rid of them, until it was found feasible to weld them together and thus use up every bit of the material at an enormous saving. It was like sticking a small piece of soap, left from the old bar, onto a new cake and getting 100 percent use of the article.

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## THE 1917 CONVENTION

Plans are being laid for the next annual meeting of the International Acetylene Association, which will be held at the Congress Hotel, Chicago, Monday, Tuesday and probably Wednesday, October 29, 30 and 31. In his announcement to the members, Secretary A. Cressy Morrison says:

"It was determined that, in spite of the unusual activities in the industry, the meeting was not only desirable but essential. So many important matters have arisen and so many changes are taking place that the meeting is becoming more important than any previous convention.

"I am sending you this first notice so that you can set aside the dates. Every member should be present. The business end of the meeting is so important and touches every phase that relates to the industry so completely that your presence is necessary.

"Arrangements will be made so that in addition to the joint session, separate sections of the industry are to have a session particularly adapted to their interests.

"The entertainment feature and the opportunity for greeting your friends, renewing acquaintance, building up closer and more harmonious business relationship will be even more fully developed this year than hitherto.

"The Secretary would appreciate and welcome further suggestions of subjects for discussion, and earnestly requests that you communicate with him at once in this regard."

---

Girls are already beginning to make their appearance among the ranks of the welders in Chicago. Several are employed in the shops of a West Side concern. They handle light work.

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## AUTOGENOUS WELDS OF BOILER PLATES.*

Method of Making Welds and and Their After-Treatment, Also Tests to Be Applied and the Field for Autogenous Welds

BECAUSE of the growing importance of autogenous welding, the Swiss Society of Steam Boiler Owners recently conducted a series of tests "to produce exact data on the actual status of the art and to assist in its development." But in these tests, as in all Swiss practice, autogenous gas and electric welding are treated separately, for gas welding alone is known as autogenous. In these tests the most frequent defects were found in the joining of the original metal to the added metal, or between successive layers of the added metal, where it was more nearly "pasted" than welded. The principal cause of these defects was that the edges to be welded were too close together.

The angle of the opening prepared for welding, whether chipped or burned out, should be at least 90 degrees, and the

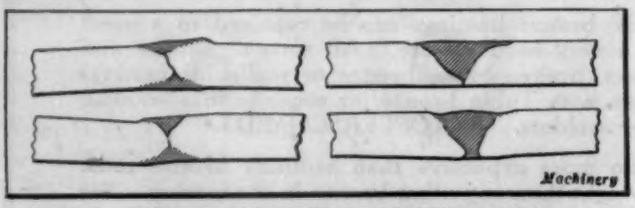



Fig. 1. Welds made with too Sharp an Angle between Surfaces

width of the bottom of the V should be at least 3/32 inch for sheets ½ inch thick. If the angle is too acute, the flame cannot penetrate to the bottom in an effective manner. It is pushed and frequently blown out so that only the upper edge is welded to the filling material, as shown in Fig. 1. On the other hand, if the slot is wide enough and open at the bottom, the flame reaches all the surface, and fuses the edges of the plate throughout their entire extent. Although the expenditure of time, metal and gas seems greater for a wide opening than for a narrow one, the reverse is true. Properly welded pieces are, without exception, made in widely opened slots, as shown in Fig. 2.

Whther it is better to weld from one side only or from both sides depends principally on the thickness of the sheet. When welding from one side, the space for the reception of the added metal is greater than if the welding is done from both sides, and it would seem as though the consumption of welding metal

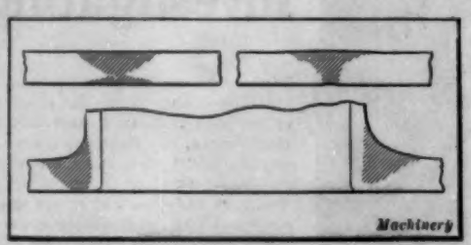



Fig. 2. Welds made with Wide Angle between Surfaces

would be greater; in practice, however, this is the case only to a slight extent. When welding from both sides, it is of the greatest importance that the welding be finished at a single heat; this is only possible, when welding from one side, in the case of thin or moderately thick plates. When welding thick plates from both sides, the two sides should be welded and hammered simultaneously.

Another cause of poor welding is insufficient preheating of the parts to be welded. This defect arises either from lack of experience or attention, for a welder who knows his trade should know the instant that the pieces of metal to be welded are in a condition to melt or flow together. Examples of this fault are shown in Fig. 3; at *A* is shown a piece of metal stuck on the plate, only the edges of which are welded.

Other grave faults, developed by the etch tests, are blowholes, deposits of oxide, soft (weak) structure, etc.; these defects also arise from lack of skill. There is also the development of oxides during the welding. Iron raised to a high temperature absorbs oxygen rapidly from the air. Since oxygen is used directly to make autogenous welds, the formation of oxides is much greater if the flame carries an excess of oxygen. It is necessary, then, to regulate the mixture of gases in the torch. On the other hand, if the flame has an excess of acetylene, the acetylene will carburize the liquid iron and transform it into steel. One must, therefore, regulate the blowpipe flame exactly right, which will be done when the core of the flame is white, very luminous and somewhat limited in size, but not

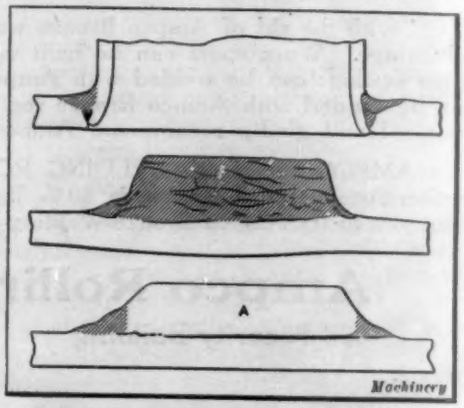



Fig. 3. Poor Welds caused by Insufficient Preheating

too short. If the core is short and the flame tinged with violet, oxygen is in excess; and when it is extremely luminous, acetylene is in excess. When the flame is well regulated, the preheating of the oxygen tends to steady the flow, although trouble may arise from the condensation of water which forms in the tubes.

Burned metal results from too high a temperature. It is facilitated when the flame carries an excess of oxygen. An oxidation and partial decarburization of the iron is produced, for which the iron itself (by its combustion) furnishes part of the heat. The action of the cutting torch depends also on a

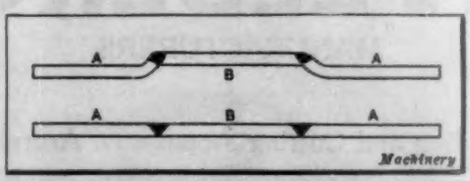



Fig. 4. Welding a Piece into a Plate

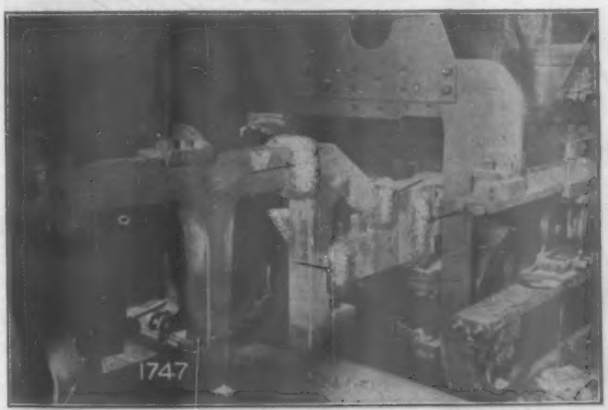
greater consumption of oxygen than does the welding torch. In this respect, the distance from the core of the flame to the weld is of great importance. Oxides are eliminated by agitating the molten metal with the welding wire, which brings them to the surface. Powder is no longer used in welding mild steel to reduce the oxides; cast iron presents a different problem. The skilled use of the torch and the welding rod will avoid oxidation. If possible, the welding wire should never make actual contact with the flame, but both should be kept in motion and in such a way as to avoid each other.

The test specimens that broke at the weld possessed on an average only 76 per cent of the strength and 39 per cent of the elongation of the unwelded pieces. The specimens that

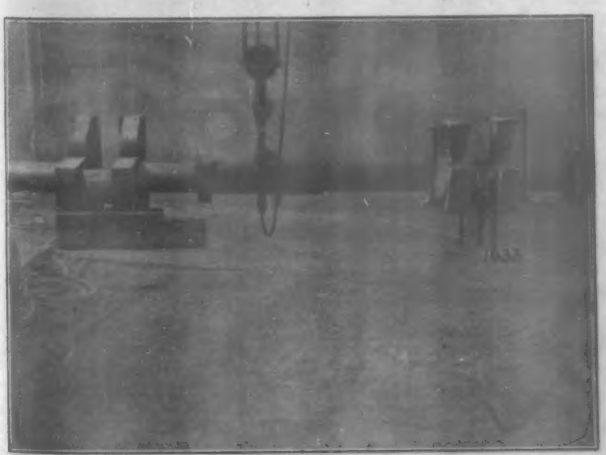
*Abstract of an article by E. Hohn printed in "The Locomotive" of Oct., 1916 and Jan., 1917.

New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.

Large bevel gear on which two new teeth and crack have been repaired.




Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.


# Thermit Does the Heavy Welding and Does It Right

The Thermit Welding Process is the only one that is best adapted to repairing of heavy sections (see illustrations).

Thermit will repair such sections quickly and economically. Many serious delays have been avoided from the use of Thermit Welding and saved thousands of dollars in time and expense.

## If you have a breakdown

wire or telephone our nearest office and we will proceed at once for arranging the shipment of materials and send an expert to supervise the repair.

We have an eighty-page pamphlet devoted exclusively to this class of work, which is known as pamphlet No. 1779, and tells how the work is executed and how you can do the work yourselves.

## Goldschmidt Thermit Co.

Equitable Bldg., 120 Broadway
New York

329 Folsom Street, San Francisco 7300 South Chicago Avenue, Chicago
103 Richmond Street, W., Toronto, Ont.

broke outside the weld had 87 per cent of the original tensile strength and 66 per cent of the elongation. Annealing may have contributed to this result, but as the average elongation fell to 54 per cent of the comparison plate, the conclusion is forced that the quality of the metal suffered. The influence of annealing was further demonstrated by tests by the Brinell process, the results of which, in general, parallel those of the tension tests. While the specimens of the unwelded plate gave a mean value of hardness $H = 115.6$, the mean for plates with autogenous welds fell to 102.8 when measured outside the weld, or 89 per cent of the hardness of the unwelded plate. When measured at the weld, the mean hardness was found to be 108.2, or 94 per cent of the hardness of the unwelded plate. The diminution of 11 per cent in hardness represents about what could be attributed to the annealing; and although the metal was somewheat harder at the weld than outside it, the difference was only 5 per cent. The softest of the autogenously welded plates had the greatest elongation—101 per cent of the unwelded plates; the hardest had the highest tensile strength—90 per cent. The electrically welded plate was harder than all the others, especially at the weld.

### THE NATIONAL WELDING COUNCIL.

Autogenous welding entered upon what is bound to be a fruitful period when recently in the Engineering Societies Building, New York City, committees of various societies and manufacturers met and formed the National Welding Council. All the industries were represented, together with the insurance companies and the constituted authorities, such for example as represented by J. C. McCable, safety engineer for the City of Detroit.

The purpose of the National Welding Council is, in the beginning at least, divided into four divisions, to accomplish the following ends: Uniformity of design of pressure vessels to be autogenous welded; licensing of welders for pressure-vessel work; research to determine an infallible test that will reveal unsafe welds, and fourth, to investigate the microstructure and physics of welds. An autogenous welding is so attractive on account of both the cost and the time of doing such work, the development of the art as applied to pressure vessels suffers because engineers who represent the public as well as private interests cannot be certain of the safety of an autogenous weld. The frank statements by Mr. McCabe, and by the insurance interests represented at the meeting by T. T. Parker, of the Fidelity & Casualty Co., and J. G. Shaw, of the Travelers Insurance Co., were most commendable. These gentlemen gave the welders to understand that until some reliable tests that would enable one to determine the safety of a weld had been found, they would not permit of the use of welds in pressure vessels subject to tension. This also is the attitude of responsible engineers, many of whom have applied welds to pressure vessels, that are unlikely to rupture or other accident, and which, if ruptured, will not cause serious damage to surrounding property or loss of life.

One of the first duties of the National Welding Council will be to gather in comprehensive form the data now available relative to welding and to the testing of welds, as well as to the microstructure. This is highly commendable for the reason that considerable is now known about welding, and the council, by properly compiling and arranging the data already at hand, will save itself considerable research work.

While of course it will take some time for the council to make important discoveries, the movement is the most commendable so far set on foot either in this or in any other country to develop the art of autogenous welding so that it may be safe as applied particularly to pressure vessels.—*Power.*

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You should attend the International Acetylene Association convention, October 29 to 31, Chicago.

# Trade News

### PROPER HEAT APPLICATIONS

The stoppage of waste and destruction by proper he applications is the subject of Bulletin No. 91-W, Just issu by the Hauck Mfg. Co., 140 Livingston Street, Brookl N. Y. The booklet contains 25 typical illustrations in m chine shop welding work and various repair jobs, includin such work as heating for expanding, straightening, brazin shrinking, removing wheels and collars, heating pipes fo flanging, bending, melting babbitt out of bearings, copper smithing, blacksmithing, case hardening, etc. The bulleti also contains some good formulas for brazing and welding fluxes and spelter. This is a bulletin which will prove both interesting and of value to every welder. Copies will be sent upon request.

### GENERAL COMPANY ENLARGES.

The General Welding & Equipment Co., 107 Massachusetts Ave., Boston, Mass., has been incorporated with a capital of $50,000.00 under the Massachusetts laws. Mr. T. F. Stoddard is President, and Dr. A. Krebs is Consulting Engineer and Treasurer.

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D. W. Dunn, Vice-President Canada Carbide Sales Company, has been commissioned a First Lieutenant in the Ordnance Department.

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H. J. Mackey, Manager Decatur Brass Works, Decatur, Ill., announces that his company will shortly market a line of welding equipment. Mr. Mackey is well known to the trade, being connected with the Federal Brass Works, Chicago.

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Mr. Thomas Duffy, Western Manager Commercial Acetylene Welding Co., Chicago, is one of the selected men of his district and has left for an Eastern Training Camp.

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At the September 17th meeting of the Western Railway Club, Chicago, Mr. E. Wanamaker, Electrical Engineer, Rock Island Lines, read a paper entitled, "Gas and Electric Welding." The paper is reprinted elsewhere in this issue.

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The National Carbide Sales Co. has been incorporated at Ivanhoe, Va., with a capital of $350,000. Work on a new plant will be started at once.

# Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

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**Wanted**—Salesman to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

---

**For Sale**—Clayton Oxygen Compressor 3 stage machine for compression up to 2,000 pounds. Displacement per minute 35 cubic feet at 150 revolutions per minute; a first class machine in strictly fine condition for immediate shipment. Address Hugh W. Dyar, 1246 Marquette Bldg., Chicago, Ill.

---

**Position Wanted**—Experienced all around welder—repair shop experience. Age 26, single, sober. Want 55 cents. Address, Rochester, care this paper.

**Messer**

**Welding and Cutting Apparatus**

Injector Type

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117-119-121 N. Seventh St., PHILADELPHIA, PA.

**IMPERIAL WELDING AND CUTTING EQUIPMENT**

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**Oxy-Acetylene Welding and Cutting**

182 Pages Fully Illustrated
Price, Postpaid, 50 Cents

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Chapter 1, Acetylene. Chapter 2, Oxygen. Chapter 3, Welding and Cutting Torch. Chapter 4, Apparatus and Installation. Chapter 5, Preparing for Welding. Chapter 6, Welding of Different Metals. Chapter 7, Welding of Sheet Metal and Pipe. Chapter 8, Welding of Various Parts.

**By P. F. WILLIS**

Written by one of the oldest and most progressive authorities on the subject of welding. An up-to-the-minute text book, written for the purpose of giving the welder the greatest amount of information for the least possible cost. The first 1,000 volumes will be sold at 50 cents after which the price will be advanced to $1.00.

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**Young Man Wanted,** for new oxygen plant. Prefer men who have had experience in electrolytic oxygen process. Splendid opportunity. Address Oxygen, care *The Welding Engineer.*

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**Partner Wanted**—Oxy-Acetylene expert can either buy out or enter established business making apparatus and coordinating job welding shop. $5,000 will handle it alone. Address, Partner, care this paper.

**Foreman Wanted**—Expert oxy-acetylene welder to take charge of shop, oversee welding, design and make torches. Part salary and part stock. Good opportunity in small manufacturing business. Address, "Designer," care this paper.

Wanted Immediately. High class man for metal welding and steel cutting. Good salary, permanent position, with long established company. Address, The Metal Welding & Supply Co., 849 Broadway, Denver, Colo.

Wanted: A first-class oxy-acetylene welder for all kinds of auto work, aluminum especially. There is an especial advantage in this position. Good hours, good salary and rapid advancement after proving worth. Give full particulars in first letter or no notice taken. Address Welder, Box 92, Copley Sq. P. O., Boston, Mass.

Wanted: First-class oxy-acetylene job welder. State experience in detail and salary expected. Address Eastern, care *The Welding Engineer.*

Wanted—Oxy-acetylene welder wishes position. Highest references. Address R 2, care *The Welding Engineer.*

Wanted—An experienced acetylene welder. Communicate with the Independent Welding Works, 510 East Water Street, Syracuse, N. Y.

For Sale—Old established welding shop, doing all kinds of auto work, marine work, boiler and heavy machine work. Population of 500,000 to draw from. Apply Standard Welding Works, 224 Webster St., Oakland, Cal.

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